LSM730302

INTERNATIONAL LASER SYSTEMS
ORLANDO, FLORIDA

MODEL NC-10/80 LASER SYSTEM OPERATION AND MAINTENANCE MANUAL

27 MARCH 1973

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WARNING

THE LIGHT OUTPUT FROM THE LASER DESCRIBED IN THIS MANUAL IS CAPABLE OF INFLICTING PERMANENT EYE DAMAGE WHICH MAY RESULT IN TOTAL BLINDNESS.

WARNING

DANGEROUS VOLTAGE
IS USED IN THE OPERATION OF THIS EQUIPMENT.

WARNING

DEATH ON CONTACT
MAY RESULT IF PERSONNEL FAIL TO OBSERVE
SAFETY PRECAUTIONS.

Never work on electronic equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid.

Whenever possible, the power supply to the equipment must be shut off before beginning work on the equipment. Take particular care to ground every capacitor likely to hold a dangerous potential. When working inside the equipment, after the power has been turned off, always ground every part before touching it.

Be careful not to contact electrical connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through vital organs of the body.

TABLE OF CONTENTS

		Page No.
A.	SYSTEM DESCRIPTION	A-1
	1. Physical Description	A-1
	2. System Specifications	A-2
	3. System Functional Description	A-2-A
B.	SYSTEM OPERATION	B-1
	1. System Interconnections	B-1
	2. Energizing Procedure	B-1
	3. Optional Operating Modes	B-3
	4. Operating Adjustments	B-3
C.	SYSTEM FUNCTIONAL ANALYSIS	C-1
	1. Optical System	C-1
	2. Cooling System	C-3
	3. Synchronization and Control	C-3
	4. Power Conversion	C-7
D.	MAINTENANCE REQUIREMENTS	D-1
	1. General Maintenance	D-1
	2. Optical Maintenance	D-2
	3. Troubleshooting Procedure	D-5
E.	SCHEMATIC DIAGRAMS AND MAINTENANCE DATA	E-1
F.	PARTS LISTS	F-1

LIST OF ILLUSTRATIONS

Figure No.	Title	Page No.
1	Laser System	Frontispiece
A- 1	System Block Diagram	A- 3
A- 2	Power Conversion Block Diagram	A- 9
A- 3	Power Converter Module Block Diagram	A-10
B- 1	System Interconnection Block Diagram	B- 2
C- 1	Optical System Diagram	C- 2
C- 2	Cooling System Diagram	C- 4
E- 1	Power Supply Schematic Diagram	E- 2
E- 2	Power Waveforms Converter	E- 3
E- 3	Power Supply Assembly	E- 4
E- 4	GP-100 Motor Driver Schematic Diagram	E- 5
E- 5	GP-100 Motor Driver Waveforms	E- 6
E- 6	GP-100 Motor Driver Assembly	E- 7
E- 7	GP-200 Synchronizer Schematic Diagram	E- 8
E- 8	GP-200 Synchronizer Waveforms	E- 9
E- 9	GP-200 Synchronizer Assembly	E-10
E-10	Low Voltage Regulator Schematic Diagram	E-11
E-11	Low Voltage Regulator Assembly	E-12
E-12	Power Converter Module Schematic Diagram	E-13
E-13	Power Converter Module Assembly	E-14
E-14	High Voltage Assembly Schematic Diagram	E-15
E-15	High Voltage Assembly	E-16
E-16	High Voltage Regulator Schematic Diagram	E-17
E-17	High Voltage Regulator Assembly	E-18
E-18	Transmitter Schematic Diagram	E-19
E-19	Transmitter Right Side	E-20
E-20	Transmitter Left Side	E-21
E-21	Cavity Assembly	E-22
E-22	Cooling System Assembly	E-23
E-23	GP-400 Trigger Generator Schematic Diagram	E-24
E-24	GP-400 Trigger Generator Assembly	E-25
E-25	Umbilical Cable Schematic Diagram	E-26

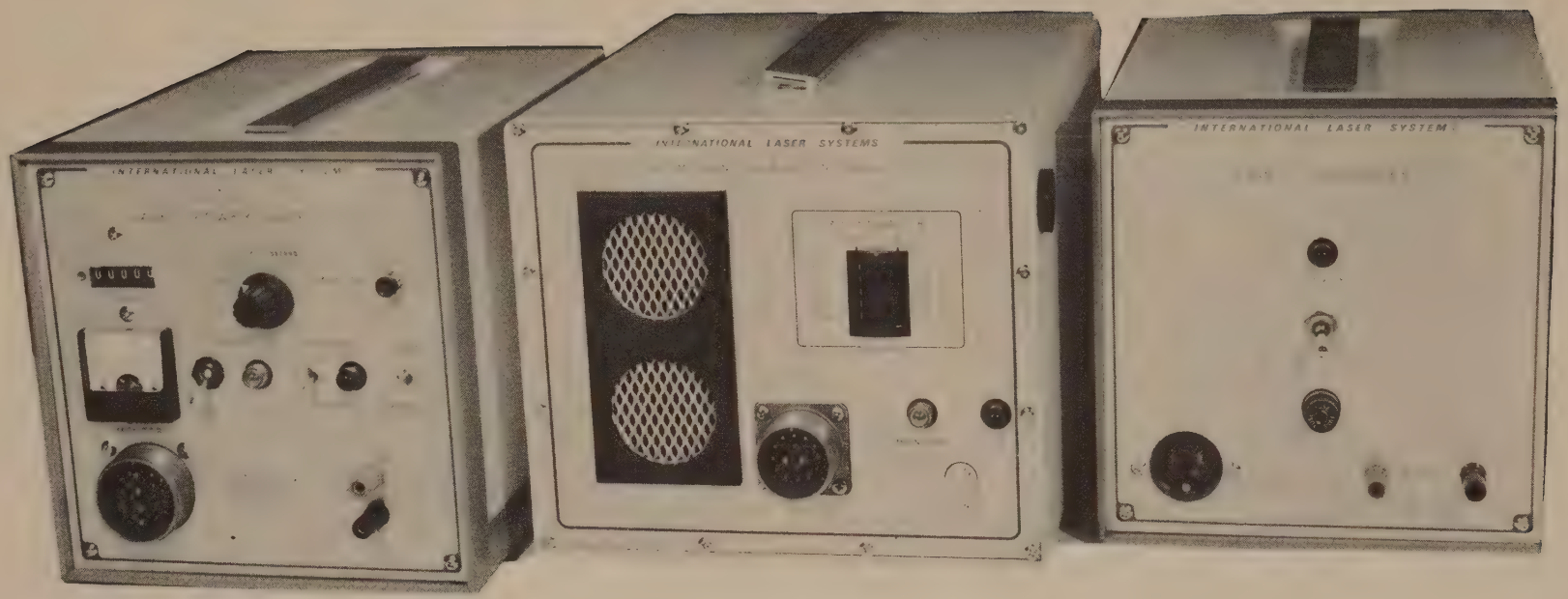
LIST OF APPENDICES

Appendix No.*	Subject
I	AC-DC Line Converter
II	Threshold Power Monitor
III	Analog Power Monitor
IV	Remote Control/Monitor
V	Shots Counter
VI	Normal Mode Operation
VII	Sighting Telescope
VIII	Shipping and Carrying Cases
IX	Synchronized Pulse Output

*Only Appendicies pertinent to the delivered system are included in this manual.

LIST OF ABBREVIATIONS

F/F	-	Flip Flop
HV	-	High Voltage
IC	-	Integrated Circuit
LV	-	Low Voltage
MV	-	Multivibrator
ND	-	Neutral Density
P/M	-	Power Monitor
SCR	-	Silicon Controlled Rectifier
SS	-	Single Shot
ST	-	Schmidt Trigger
T/M	-	Telemetry



INTERNATIONAL LASER SYSTEMS, INC.

MODEL NC–10/80 LASER CALIBRATION SOURCE

A. SYSTEM DESCRIPTION

1. Physical Description

The International Laser Systems Model NC-10/80 calibration source consists of two units: a laser transmitter and a DC power supply.

The transmitter is a dynamically Q-switched neodymium-YAG laser capable of producing a one megawatt 20 nanosecond pulse of coherent energy at a wavelength of 1.06 microns. Five operating modes are switch selectable: single shot, 1 pps, 5 pps, 10 pps, and 20 pps. A pulse, synchronized to the laser output pulse, is available at the BNC outlet provided on the operator's panel of the transmitter unit.

The power supply operates from a 24 volt DC source and provides the voltage conversion, regulation and energy storage requirements of the system. In addition, synchronization, control, and Q-switch motor drive functions are contained in the power supply cabinet.

Several accessories that extend the usefulness and versatibility of the system have been included. These accessories are:

a. Threshold power monitor.
b. Analog power monitor.
c. Shot counter.
d. Laser output sync pulse.
e. 110V to 28V power converter.
f. 10^{-6} dynamic range extension unit.
g. Carrying case.

Accessories a. through e. are explained in appendicies I through V and IX.

The power supply (Figure 1) operates from a 24V DC source which may be either battery supplied, furnished by a heavy duty laboratory supply, or optionally from a matching AC line converter to run from 110V, 60 cycle, single phase AC power.

The power supply furnishes the voltage conversion, regulation, and energy storage requirements of the transmitter. In addition, transmitter synchronization, control, and Q-switch motor drive functions are housed in the power supply cabinet.

2. SYSTEM SPECIFICATIONS

a. Transmitter

Output Wavelength	1.06 microns
Pulse Repetition Rate	1 pps, 5 pps, 10 pps, 20 pps, and single shot
Output Pulse Power Range	Without optional 10^{-6} range extension unit 10^{-7} to 10 W/CM^2 nominal adjustable in 3 db steps With optional 10^{-6} range extension unit. Same as above, and in addition, 10^{-13} to 10^{-5} W/CM^2 nominal adjustable in 3 db steps
Output Pulse Width	20 nanoseconds nominal
Output Beam Divergence	10 milliradians nominal
Output Aperture	3.5 inch diameter
Output Pulse at Calibration Port	20 millijoules nominal
Head Dimensions	12" long x 8" high x 5" wide
Head Weight	11.0 pounds

b. Power Supply

Input voltage	-nominal	24 VDC
	-minimum	22 VDC
	-maximum	32 VDC
Current input	-average	5 amps (nominal at 10 pps)
	-peak	15 amps
Voltage Output		high voltage 700V trigger voltage +250 to +300V
Dimensions		11" long x 8.3" high x 8.4" wide
Weight		12.5 pounds

Line Converter (optional)

Input Power	117 VAC amps maximum
Dimensions	11" long x 8.3" high x 8.4" wide
Weight	24.4 pounds

3. System Functional Description

The NC-10/80 laser system consists of two main units, a power supply and a transmitter, which are diagrammed in Figure A-1. The power supply performs energy conversion and transmitter control functions, while the transmitter unit produces the pulses of coherent laser energy.

a. Power Supply

Input power is derived from a 24 volt DC source which may be a 24 volt storage battery, or a 24 volt DC power supply capable of furnishing 25 amperes of peak current. Input power is controlled by a power relay that in turn is operated by a switch either locally (on the power supply) or remotely (from an accessory remote power control and monitor). A choke input L section filter provides line isolation between the primary power source and the laser system. High voltage energy for the flashlamp is produced by the power converter and stored in the energy storage capacitor until the flashlamp is triggered.

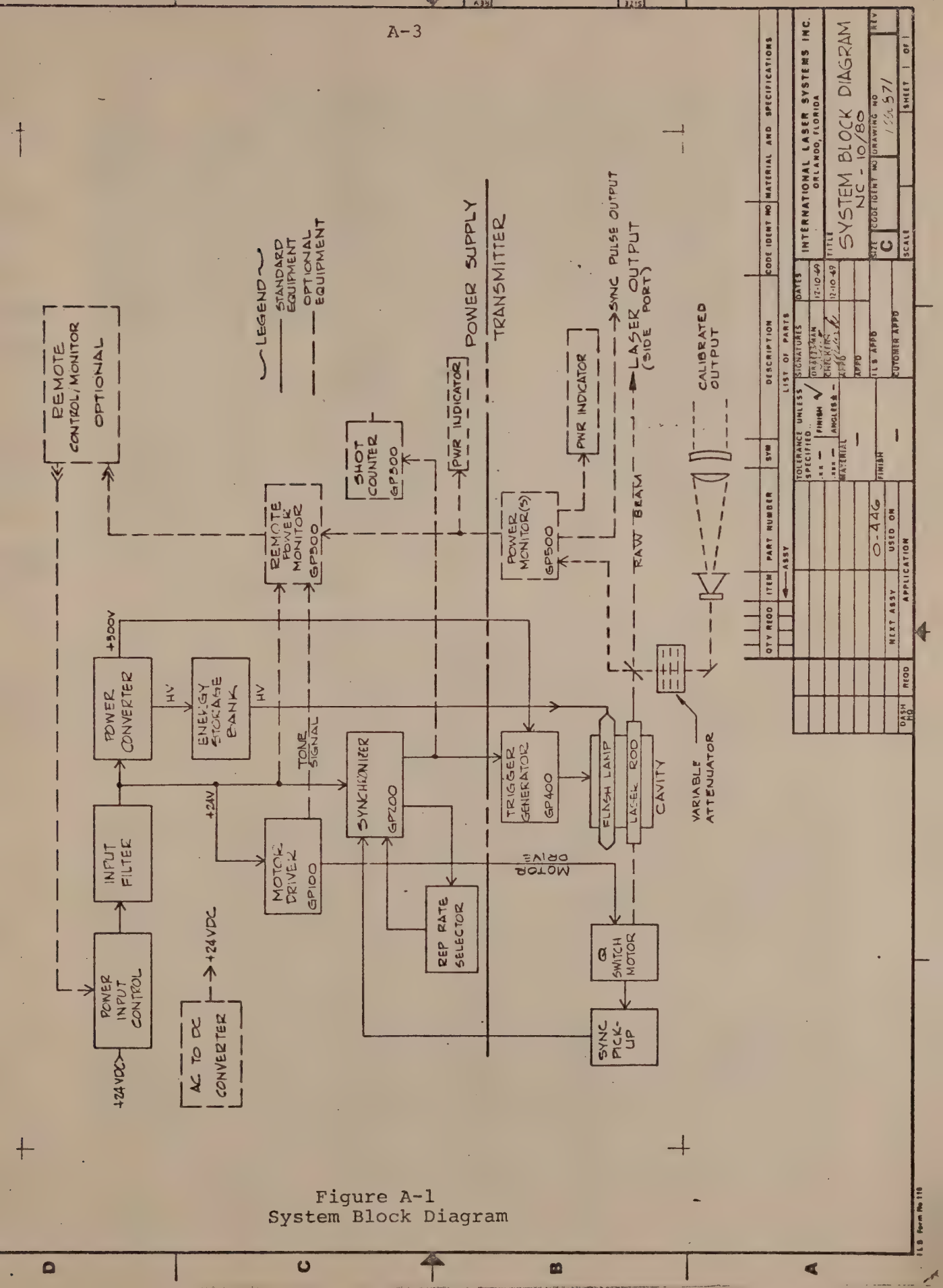


Figure A-1
System Block Diagram

Primary 24V power is also applied to the motor driver (GP-100) and synchronizer (GP-200) circuits. The motor driver produces 400 cycle AC power from a stable oscillator source. This power is applied to a 2 phase hysteresis-synchronous motor which spins the Q-switch prism at 24,000 rpm. On the edge of the spinning prism mount is located a small ferrous chip. As this spinning chip passes a magnetic pick-up coil mounted adjacent to the rim, a voltage pulse is generated in the coil. This pulse is used to synchronize the firing of the flashlamp to the prism position.

The sync pulse from the pick-up is applied to the GP-200 synchronizer circuit where it is digitally counted and a firing pulse is generated at the proper repetition rate. The counter circuit has outputs at 20, 10, 5 and 1 pps rates. The desired rate is chosen by the rep rate selector switch on the front panel of the power supply. In addition, a single shot capability has been designed to produce one firing pulse each time the fire pushbutton is depressed.

b. Transmitter

The laser transmitter contains the optical elements of the interferometer and a collimating telescope to expand the beam diameter and reduce the beam divergence of the output pulse. The interferometer consists of the rotating Q-switch prism (in an optical doubler configuration) laser rod, and partially reflecting mirror, plus several folding prisms used to increase the effective interferometer length. (See Figure C-1).

The high voltage pulse required to fire the flash-lamp is generated by the GP-400 trigger generator in the trans-mitter. The selected pulse from the synchronizer in the power supply is used to turn on an SCR within the trigger generator. This allows a capacitor, that has been charged to 300 volts, to discharge through a high voltage pulse transformer,generating a flashlamp trigger pulse in excess of 10 KV.

c. System Accessories and Options

Several accessories are available to increase the versatility and convenience of the NC-10/80 laser system. Applicable options are individually documented as appendices to this manual. The accessories/options available are:

1. AC line converter - an AC to DC converter that matches the power supply in physical and electrical parameters. This unit operates from a nominal 110 volt, 60 cycle, single phase power source, and provides 24 volts DC with sufficient current capability to supply the complete system.

2. Shots counter - a five digit electromechanical counter is available to digitally read out the number of shots on the unit. It is connected to read every 10th shot, allowing up to one million shots to be registered before recycling. The shots counter is driven directly from the synchronizer, thus maintaining a complete and accurate count (within 10 shots) regardless of the operating rep rate.

3. Power monitor - two types of power monitoring devices are available as options to the laser system.

   a. An analog power monitor provides a linear meter readout of output power over the range of 50 to 100% of full power.

   b. A threshold detector provides a blinking light power monitor that may be set to any desired level. This monitor turns on a lamp for each laser pulse that exceeds the preset power level.

   Both power monitors receive their inputs from photodiodes viewing a beam sampler. The small fraction of energy reflected off the beam sampler (typically .25%) is measured and displayed as stated.

4. Sync pulse - another photodiode may be optionally added to produce a laser sync pulse. This pulse is produced directly by the laser energy acting on the photodiode and is useful as a T_o pulse in ranging systems or as a synchronizing pulse for other equipment operating in conjunction with the laser system.

5. Carrying cases - a fitted fiberglass carrying case is available to provide shock and environmental protection to the transmitter, power supply, cables, and remote box. The case provides a convenient and secure method of transporting and shipping the system, and is fitted with a pressure relief valve to compensate for pressure changes encountered during air transport.

d. Power Conversion

There are several basic system design considerations which have particular importance in a capacitor-discharge application:

1. Survival of the system through millions of abrupt discharge cycles must be insured through a design which protects the semi-conductors from transients resulting from the nature of the load.

2. Ruggedness, low weight, and high efficiency are required despite a wide range cyclic load.

3. A consistent final output voltage must be maintained regardless of power source voltage variations.

4. RFI resulting from switching transients and RF energy propagated back through the system must be adequately isolated from the power source.

5. Peak source current and low frequency source current ripple must be minimized.

The most advantageous manner of accomplishing objective 5. above is by charging the energy storage capacitor at a constant power rate. By this method, the average current supplied to the capacitor is high when the capacitor voltage is low, and decreases inversely as a function of capacitor voltage.

The power conversion system utilized in this unit accomplishes all these objectives by use of a special high frequency energy storage transformer and associated drive, regulation, and control circuitry.

The converter receives its power through a circuit breaker, control relay, and input LC filter (Figure A-2). The input filter reduces incoming ripple when operation is from an AC to DC converter, and reduces "crosstalk" from the power supply to other systems.

The 24 volt power is regulated at +15V in a low-voltage, zener referenced, series regulator. The regulated 15 volts is used to power a 10 Khz Royer oscillator that provides two out-of-phase square waves to drive the two pairs of power converters. A secondary winding on the drive oscillator provides +300VDC for use in the flashlamp trigger generator.

The power converters (Figure A-3) couple the drive signal through a transformer to power transistor switches. When turned on, these transistors allow source current to flow through the energy storage transformer primary winding. As the current increases, energy is stored in the increasing magnetic field of the transformer. The secondary winding of the transformer is effectively open by a reverse biased diode at this time.

When the primary current reaches a maximum allowable value as determined by a current sensing network, the control circuit effectively shorts out the drive transformer and turns off the power switch. The collapsing magnetic field of the power transformer reverses the polarity of the secondary winding, forward biases the secondary diode, and transfers the induced electrical energy to the storage capacitor.

As the voltage across the capacitor increases, a high voltage sensing network (Figure A-2) supplies a small sample of this voltage to a transistor regulator. At a preset voltage, the regulator supplies an inhibit signal to the control circuit within the power module and prohibits the drive transformer from turning on the power switches. If the HV bleeds down, the regulator will allow further action to restore the HV to its preset value.

When the storage capacitor is discharged (dumped) into its load, the rapid fall of the HV is sensed by the quench circuit and an inhibit signal of a few milliseconds is generated and used to prevent power conversion from beginning until the flashlamp has extinguished.

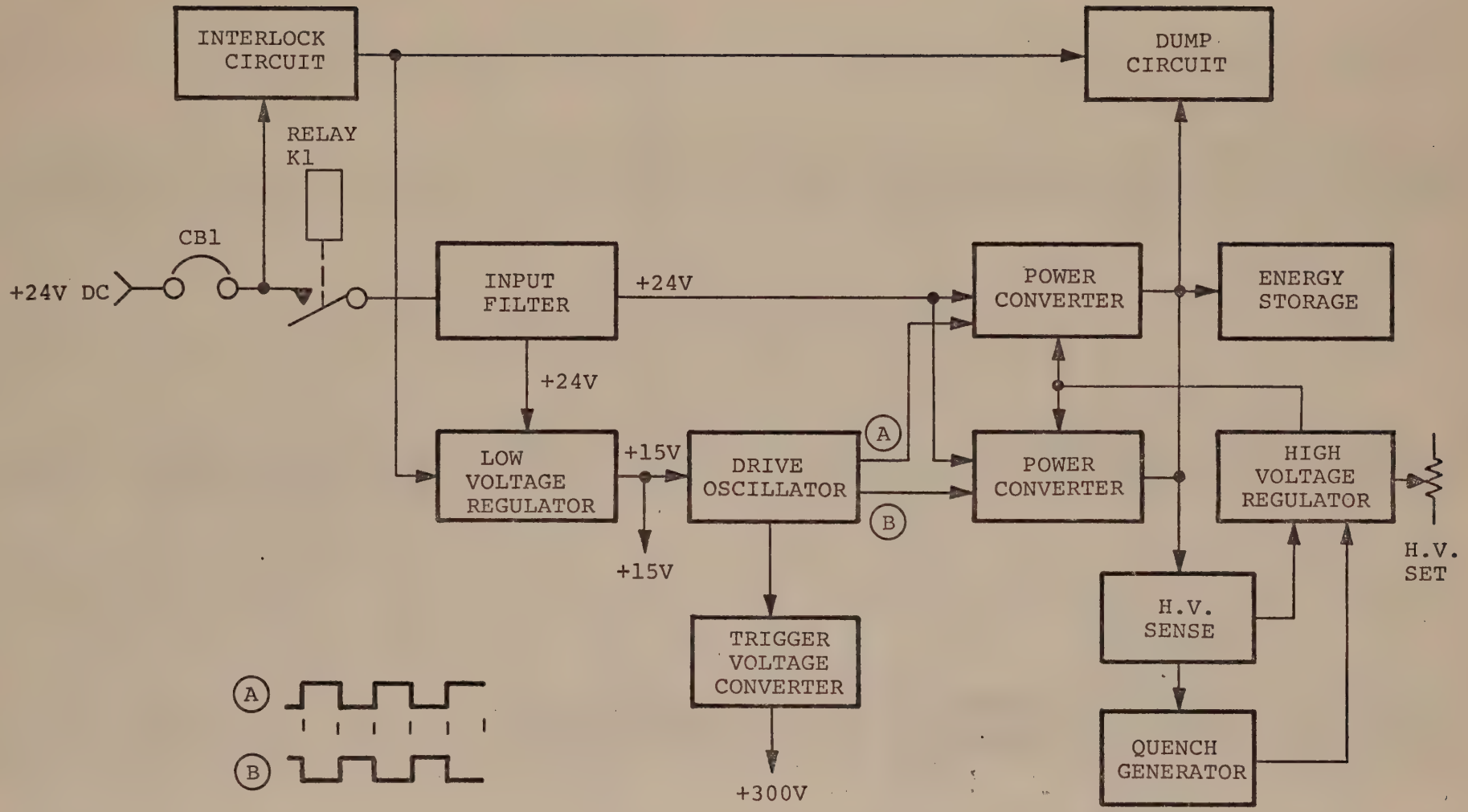


Figure A-2. Power Conversion Block Diagram

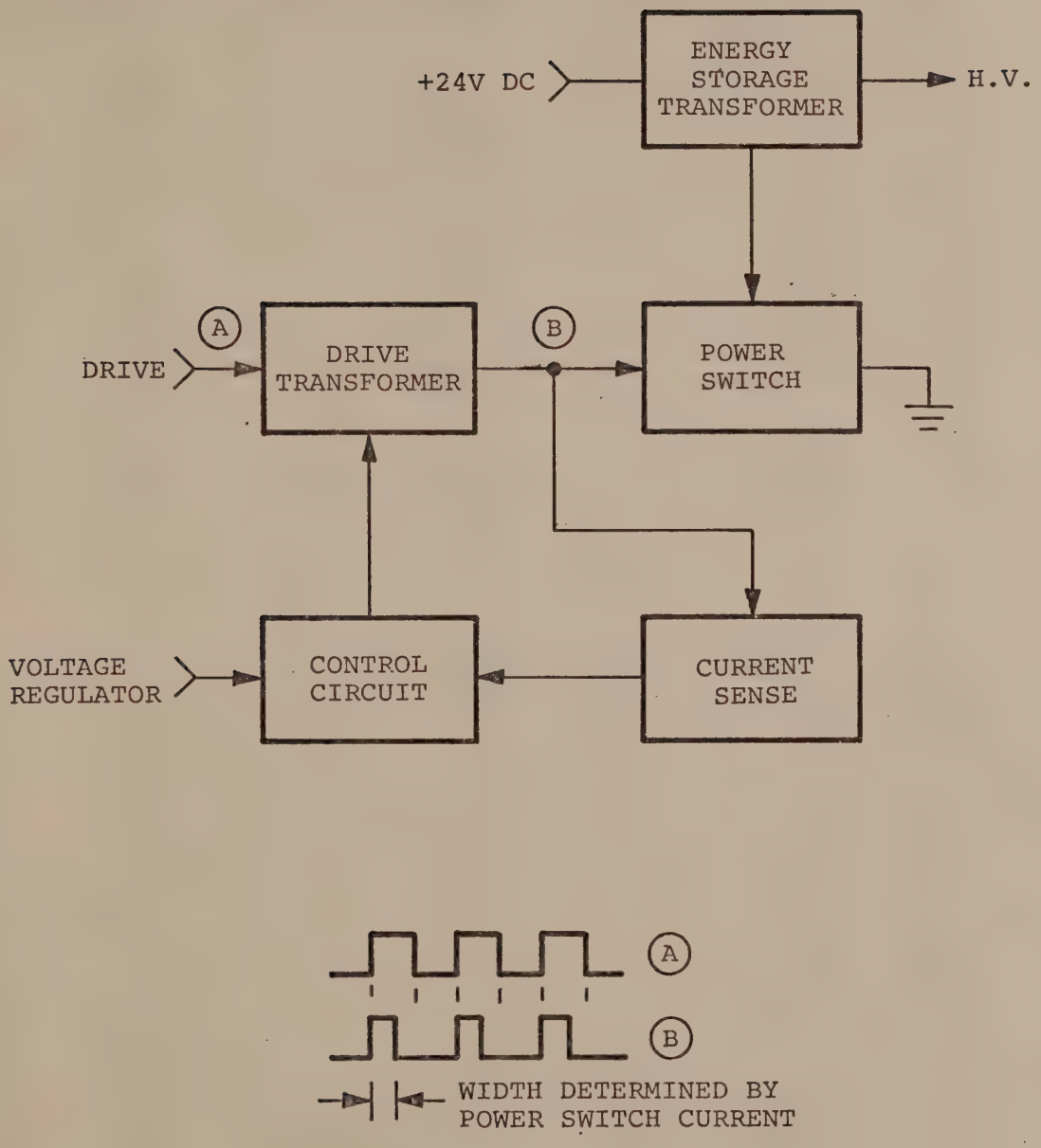


Figure A-3. Power Converter Module Block Diagram

A safety interlock circuit protects personnel by discharging the storage capacitor through a high voltage relay dump circuit and prevents further generation of high voltage by inhibiting the 15 volt regulator. This will prevent converter drive signals from being generated.

B. SYSTEM OPERATION

1. System Interconnections (Figure B-1)

Only one cable is required to connect the system for local operation. The umbilical cable has dissimilar connectors and cannot be incorrectly mated. One end is branched, with the branch terminating in two battery clamps.

Connect the branched end of the cable to the power supply, the unbranched end to the transmitter and the battery clamps to the 24 VDC power source, red to positive (+) and black to negative (-).

CAUTION INPUT POWER (24 VDC) MUST BE DISCONNECTED WHEN MATING OR UNMATING CABLE CONNECTORS

2. Energizing Procedure

a. With all connections made and 24 VDC applied to the primary power cable, turn on the POWER circuit breaker (see Figure 1). The amber power lamp will illuminate, indicating 24 volts has been applied to the system.

NOTE: IF THE CIRCUIT BREAKER TRIPS IMMEDIATELY INPUT POWER POLARITY IS INCORRECT OR THE POWER SUPPLY HAS AN INTERNAL SHORT CIRCUIT. DO NOT ATTEMPT TO RE-ENERGIZE UNTIL THE CAUSE HAS BEEN FOUND AND CORRECTED. IF THE POLARITY OF THE INPUT POWER HAS BEEN INADVERTENTLY REVERSED, CROWBAR DIODE CR3 IN THE POWER SUPPLY MAY BE DAMAGED AND SHOULD BE CHECKED BEFORE ATTEMPTING TO RE-ENERGIZE.

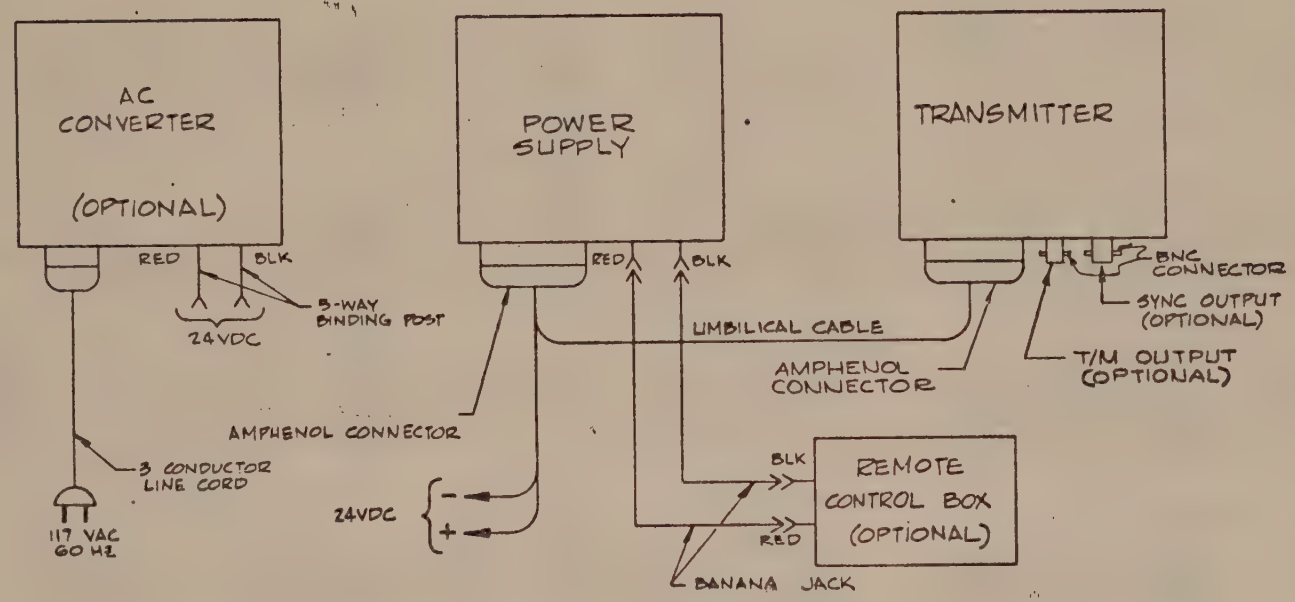
b. Set the LOCAL-REMOTE switch to the local position.

c. Set the LASER PULSE REPETITION RATE select switch to the desired rate.

d. Set the OPERATE-STAND BY switch to the operate position. The green operate lamp will be illuminated, indicating the laser is operating.

CAUTION THE TRANSMITTER WILL BEGIN PRODUCING LASER PULSES AS SOON AS THE OPERATE SWITCH IS ACTIVATED. EYE PROTECTION MUST BE IN PLACE PRIOR TO ACTIVATION.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



SYSTEM INTERCONNECTION DIAGRAM

Figure B-1
System Interconnection Block Diagram

B-2

QTY REQD	ITEM	PART NUMBER	SYM	DESCRIPTION	CODE IDENT NO	MATERIAL AND SPECIFICATIONS
← ASSY				LIST OF PARTS		

TOLERANCE UNLESS SPECIFIED .XX FINISH ✓ .XXX ANGLES ±	SIGNATURES / DATES
MATERIAL	DRAFTSMAN: [illegible] 8-22-71
FINISH	CHECKER
NEXT ASSY: 0-454	APPD
USED ON	APPD
APPLICATION	ILS APPD
DASH NO.	CUSTOMER APPD

INTERNATIONAL LASER SYSTEMS INC.
ORLANDO, FLORIDA

TITLE: SYSTEM INTERCONNECT DIAGRAM LT50/20HB

SIZE	CODE IDENT NO	DRAWING NO	REV
C		1001962	

SCALE: | SHEET 1 OF 1

3. Optional Operating Modes

a. Single Shot Operation

With the repetition rate switch set to the single shot position, laser pulses will be generated each time the single shot push button is depressed.

b. Output Power Control

An adjustable attenuator having a total range of 79 db is provided on the front of the laser head. This allows the output power density to be varied in steps of 3 db from approximately 10^{-7} watts per square centimeter to 10 watts per square centimeter. The dynamic range extension unit supplied with the system provides an additional 10^{-6} attenuation. If desired, this unit may be attached to the front of the laser telescope to allow the output power density to be varied in steps of 3 db from approximately 10^{-6} to approximately 10^{-13} watts per square centimeter.

4. Operating Adjustments

The NC-10/80 laser source has been designed to be a highly reliable, long life system, requiring minimal maintenance. To this end, the optical portion of the transmitter has been enclosed to prevent moisture vapor and dust particles from degrading the optical surfaces. In addition, the entire interferometer has been ruggedized so that, with reasonable handling and care, optical realignment should not be required.

Electronic circuits in the power supply have been designed and constructed conservatively to assure that the system operating level is well below maximum ratings.

There is only one item requiring relatively routine adjustment:

> High Voltage Adjustment: A voltage adjustment potentiometer located at the rear of the power supply (See Figure E-3) will control the energy input to the flashlamp. This voltage may be periodically increased to compensate for flashlamp aging. The normal life for this type flashlamp is in excess of 30 hours running at 10 pps.
>
> Flashlamp aging is detected by a gradual fall-off in laser output power. When this fall-off has reduced the power output below an acceptable level, increase the pump voltage to just restore power.

CAUTION

DO NOT OVER-PUMP THE FLASHLAMP. EXCESS PUMP ENERGY, WHILE CAUSING NO DAMAGE, WILL CREATE MULTIPLE LASER PULSES AND/OR OUTPUT PULSE BROADENING.

Pump voltage may be measured with a suitable voltmeter when the laser is set for single shot operation.

WARNING

LETHAL VOLTAGES ARE PRESENT IN THE POWER SUPPLY.

When the pump voltage approaches the maximum output of the power supply, as specified in Section A, it is an indication that the flashlamp has reached the end of its life, and needs replacing. (The rate of energy fall-off will rapidly increase as the lamp nears its end point.)

C. SYSTEM FUNCTIONAL ANALYSIS

1. Optical System

The optical subsystem contains the 5 mm x 37 mm neodymium-YAG laser rod, coupled to a Xenon flashlamp in a liquid cooled elliptical cavity. The front (output) reflecting surface of the interferometer is a dielectrically coated mirror mounted between the laser rod and the 90° folding prism. Q-switching is accomplished by a prism mounted on a single rotating shaft in an optical doubling arrangement. Rotation is via a tuning-fork controlled, hysteresis-synchronous motor, rotating at 400 revolutions per second. Thus, with the optical doubling arrangement, an effective rotational switching speed of 288,000 degrees per second is achieved.

The entire interferometer is mounted within a sealed chamber to prevent white pump-lamp light or stray 1.06 micron radiation from leaving the head. The sealed interferometer cover also protects the optical system from the adverse affects of humidity and dust in the operating environment.

The laser head incorporates a threshold energy monitor and a high intensity output port for calibration purposes. The energy monitor provides a flashing amber light on the head control panel when the output power density is above a preset level. This level is nominally 5 watts per square centimeter at the 0 db setting. On the upper right hand side of the head is a removable plug. When removed, the primary output beam of the laser exits from this port; an output of approximately 20 millijoules corresponding to an unattenuated output from the 3 1/2" objective of 10 watts per square centimeter.

The transmitter utilizes P1 (see Figure C-1) as one terminus of the interferometer. From there, the optical path is to the Q-switch prism, through the laser rod to the 85% mirror. At this point the majority of the energy remains in the interferometer to sustain oscillations and to be re-amplified by two more passes through the rod before returning to the 85% mirror.

The output from the 85% mirror is folded in two directions by the folding prism. One output is routed to a beam splitter, which passes one portion of the raw laser beam to the side port (nominally 20 millijoules). The other portion of the beam is diffused and routed to the optional photo diode assembly for use in generating the T_o output sync pulse and the power monitor signals. The second output from the folding prism is the calibration beam. This beam passes through an output calibration attenuator, a 1.06 micron pass filter and none or one or more of the five neutral density attenuator filters. From there, the beam is folded by the front surface mirror and passed

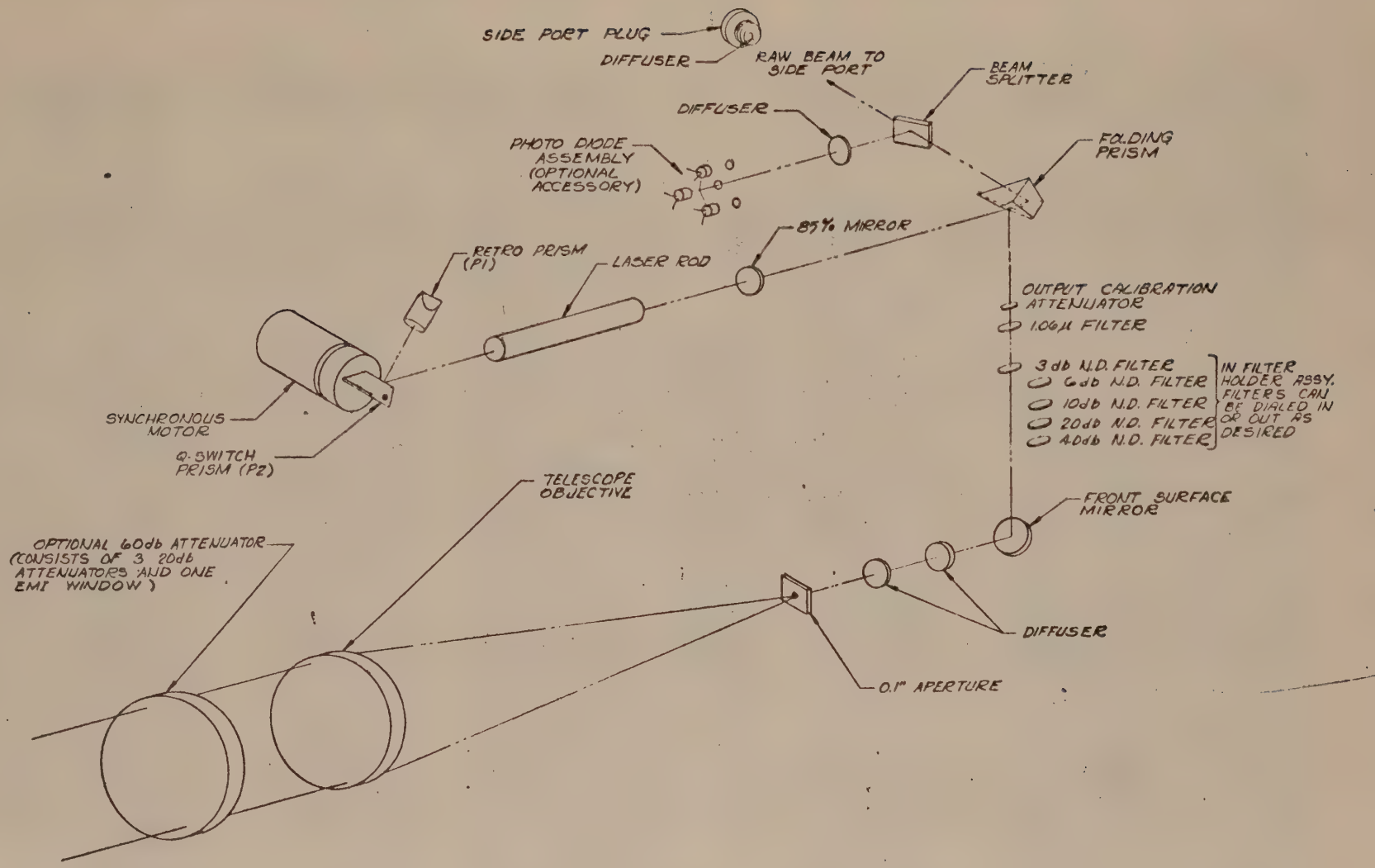


Figure C-1
Optical System Diagram

to the 0.1 inch aperture which is located at the focal point of the telescope objective. The beam exits from this aperture and passes through the telescope objective and, optionally, through the 60 db attenuator. This unit consists of three 20 db attenuators mounted in a single package.

The output calibration attenuator previously discussed is used to preset the intensity of the output beam. With the laser producing a nominal 20 millijoules raw beam at the side port, and no attenuation filters in the beam path, the density value of the output calibration attenuator is selected to provide an output beam intensity of 10 watts per square cm.

2. Cooling System

The laser cooling system consists of a magnetically coupled circulating pump, replaceable ion-exchange resin filter, coolant reservoir, and a blower cooled liquid-to-air heat exchanger. The coolant utilized is a 50% mixture by volume of distilled, de-ionized, filtered water and analytical reagent grade ethylene glycol.

CAUTION: DO NOT USE COMMERCIAL GRADES OF DISTILLED WATER OR ETHYLENE GLYCOL IN THE COOLING SYSTEM

The pump and blower motors are 24 volt DC motors that are operated by main power relay K1. Coolant is drawn from the main reservoir by the pump, circulated through the heat exchanger, laser cavity, resin filter, and back to the reservoir. Each side of the laser cavity contains a diaphragm to compensate for coolant expansion/contraction due to temperature or ambient pressure changes. The pump inlet and the ion-exchange resin filter outlet are mounted directly on the reservoir.

The entire cooling system has been fabricated from inert materials to reduce the possibility of water contamination. The full-flow ion exchange resin filter will continuously "polish" the water to remove any ions that may be generated by the high ultra-violet environment within the laser cavity. This filter should be replaced periodically.

3. Synchronization and Control

Laser synchronization and control circuits generate Q-switch motor drive power, and trigger the flashlamp at the proper time to achieve optimum laser efficiency. These functions are performed by two printed circuit cards located in the power supply: GP-100 motor driver, and GP-200 synchronizer. (See Figure E-3).

a. Motor Driver Operation (See Figure E-4)

Filtered +24VDC is applied to the GP-100 card at pin C for the low level circuits and pin B for the power circuits. Transistor Q101 and diode CR103 comprise a 5 volt regulator to produce the correct voltage for micro-logic and drive stages.

FIGURE C-2 DELETED

A stable oscillator module (G101) produces a square wave signal. This square wave is applied to A103 for frequency division. The half-frequency output of A103 is amplified by Q111 and used to toggle a bi-stable F/F in A101 (pin 13). The complementary, quarter-frequency outputs of the Q and $\overline{Q}$ output of the F/F at pins 8 and 9 of A101 are gated to the driver transistors by a quad 2-input gate integrated circuit designated A102.

Transistors Q106, Q107, Q102, and Q103 make up a power bridge circuit. Power is delivered to the load (motor) through R114, Q106, Q103, and R106 for one half-cycle, and through R114, Q107, Q102 and R106 for the alternate half cycle. A positive signal from the gated output of A102 at pin 3 will turn on Q107 and Q102 through Q105. Similarly, a positive output from the gate at pin 11 of A102 will turn on Q106 and Q103 through Q104. Assuming the half cycle during which Q106 and Q103 are conducting anc Q107 and Q102 are cut off, ($\overline{Q}$ output of the driver F/F is low, gate output at pin 11 of A102 is high) the output of pin 6 of A102 is high due to the low input from $\overline{Q}$. This causes Q109 to be turned on, providing a path to ground for base leakage current through Q107 (off). This insures that the non-conducting half of the bridge will not partially conduct. Q108 performs the same function during the other half cycle.

If,during any given half cycle, the current through the bridge and the load becomes excessive, the positive voltage developed across current sensing resistor R114 will turn on Q112 through R116. When turned on, Q112 will trigger the second F/F within A101. This F/F is set at the beginning of each half cycle to provide a high (+) output from pin 6. This output has no effect on the gates within A102. However, when Q112 is triggered by the excessive current signal, the Q output is set to its low state, producing a high output from both gates at pin 6 and 8 of A102. This condition turns on both Q108 and Q109, which in turn apply ground to Q106 and Q107 to shut off the current through the bridge. Diodes CR101 and CR102 prevent the motor's inductive overshoot from exceeding the system B+.

Resistor R117 samples the AC signal from one side of the power bridge to supply an audible tone for the remote power monitor circuit if it is incorporated.

b. Synchronizer Operation (Figure E-7)

The synchronizer digitally counts the pulses from the magnetic pick-up coil mounted adjacent to the Q-switch and produces a flashlamp trigger pulse at the selected rate. Since the Q-switch motor is synchronized to the frequency stable drive, and a ferrous chip in the periphery of the prism mounting wheel sweeps across the pick-up coil once per revolution, the pick-up produces a pulse every revolution. These pulses are generated at a constant time ahead of the instant the Q-switch is aligned. That time is determined by the angular relationship between the Q-switch alignment position and the sync pick-up. This time is increased by increasing the pick-up to prism alignment angle and decreased by reducing the angle.

The synchronous input pulses are applied to amplifier Q202 on the GP-200 synchronizer printed circuit board. The amplified pulse train then triggers a monostable multivibrator consisting of two gates within the A203 integrated circuit and timing capacitor C210. This configuration is used to isolate the succeeding counter chain from ringing noise pulses generated when the flashlamp is fired. The counter chain is composed of (in order) 1/2 of dual F/F A201, decade divider A204, dual F/F (both stages) A202, and decade divider A205. The decade dividers A204 and A205 have the capability of extracting various counts up to 10. Counter A204 is connected for a full 10 count by the connection of pins 8 to 12. Counter A205 is connected as a divide by 2 and divide by 5 counter by the connection of pin 5 to 6.

The divided counts are applied to A206 at pins 3, 1 and 13 respectively. The purpose of the dual inversion is noise isolation; to prevent noise pulses from being introduced to the counter chain via the rep rate selection switch wiring leads. These pulses are applied to rotary selector switch S1 on the power supply front panel. The selected rep rate pulses are returned from the wiper of switch S1 to pin F of the circuit where they trigger a monostable multivibrator consisting of the remaining two gates of A203 and timing capacitor C212. The pulse generated by this one-shot MV is amplified by A201 and used to turn on the SCR in the flashlamp trigger generator. The same pulse is applied to all sections of the counter chain to reset them in preparation for the next count-down.

In the single shot mode of operation, a negative signal from the second F/F in A201 (pin 9) is applied through the rep rate switch in the SS position to pin N of the circuit and serves as a counter inhibit signal to the J&K (pins 3 and 2) inputs to the first counter stage. Depressing the single shot pushbutton supplies a ground to the SS control F/F (A201 pin 13) to toggle the F/F. The resulting positive output of A201 pin 9 allows the counter to operate. After 80 counts the 10 pps output of the counter produces a pulse which is coupled through the rep rate switch in the SS position to the trigger generator multivibrator (A203 pin 1). The resulting trigger pulse resets the counter and the SS control F/F and triggers the flashlamp. Resetting the SS control F/F again inhibits the counter chain. Thus, a flashlamp trigger is generated, in sync with the Q-switch, 80 counts or approximately 100 milliseconds (+0 to 1.25 ms) from the time the SS pushbutton is depressed. This system prevents SS generation from occurring at a rate faster than 10 pps, such as might occur from switch noise.

Transistor Q203 and diode CR202 form a 5 volt series regulator to provide operating voltage for the integrated circuits.

4. Power Conversion

a. Low voltage regulator and driver (12G0007, Figure E-10).

The low voltage regulator reduces the unregulated +24 volt input to +15 volts. Zener diode D4 serves as the reference voltage source for driver transistor Q5 and series regulator Q4. The unregulated +24V is applied to the reference diode D4 through R6, Q3, and D3, providing control transistor Q2 is not conducting. Transistors Q1 and Q2 provide a control function that will turn the regulator off if the input to Q1 is not sufficiently positive. Diode D1 receives +24 volts through the interlock circuit in both the power supply and the transmitter. This voltage keeps Q1 conducting, placing a ground on the base of Q2 which keeps Q2 cut off. If the voltage is removed, Q1 turns off and the +24 volts through R3 will turn on Q2. This in turn places a ground on the base of Q5, cutting Q5 and Q4 off and removing +15 volts from the power converter circuits.

Saturable transformer T1, and transistors Q6 and Q7 are a self excited, square wave Royer oscillator operating at approximately 10 Khz. R7 and R19 are the positive feedback resistors to drive Q7 and Q6 respectively. The output is taken from the center tapped secondary at pins F, and H. The outputs at pins F and H are complementary square waves.

The high voltage for the flashlamp trigger generator is also produced by this oscillator. Diode bridge D6-D9 rectifies the voltage developed across the untapped secondary of transformer T1 and produces approximately +300V.

Transistors Q8, Q9, and Q10 produce the quench signal to inhibit the power converter after the flashlamp is fired. The drop of the high voltage that occurs when the lamp is triggered is sensed in the high voltage assembly and supplied as a negative pulse to pin L of this circuit. Q8 and Q9 are a monostable multivibrator with Q9 normally conducting. The negative quench sense pulse reduces Q9 conduction and trips the multivibrator into its other state. C3 is the timing capacitor that produces a positive pulse of approximately 5 milliseconds duration on the collector of Q9. This pulse turns on Q10, providing a ground pulse at pin M of the circuit that begins when the flashlamp is triggered and lasts for 5 milliseconds. This pulse prevents the converter from reacting to the drop in high voltage until the lamp has extinguished.

b. Power Converter Module (12G0013, Figure E-12)
The power converter module produces the high voltage required to charge the energy storage capacitor. This capacitor is charged at a constant power rate to reduce the peak current demands on the primary power source. The power converter module must not be operated without a load (HV capacitor) on the high voltage output.

Transformer T1 is the high voltage, non-saturating, energy storage transformer. Current will flow from the +24 volt source through its primary winding pins 1 and 2, through control transformer T2 winding pins 1 and 2, and through power transistors Q2 and Q4 to the 24 volt return (ground). From the time the power transistors begin to conduct, the current will increase at a rate limited by the inductive reactance of T1 primary. As this current increases, a voltage will be induced in T1 secondary that is negative at pin 4, thereby reverse biasing high voltage diode D8. With D8 reverse biased, no

current can flow in the secondary. The increasing primary current stores energy in the transformer by increasing the magnetic field within the transformer.

When the power transistors are turned off, the primary current will cease, and the collapsing magnetic field of T1 will induce a voltage of the opposite polarity in the secondary winding, forward bias diode D8, and transfer the inductively stored energy to the storage capacitor.

Transformer T2 in the power converter module is the control and driving transformer. The incoming drive signal, a 10 Khz square wave is applied to primary winding, pins 6 and 5. The power transistors Q2 and Q4 are driven by secondary winding pins 3 and 4. When the negative going square wave at pin 6 induces a positive voltage at pin 3, Q2 and Q4 begin to conduct.

Current through power transformer T1 flows through T2 winding at pins 1 and 2. This current increases the positive voltage at pin 3 of T2. Thus regenerative action occurs, driving Q2 and Q4 to saturation very quickly, minimizing the I^2R losses in Q2 and Q4. As current rises through Q2 and Q4 at a rate determined by the primary winding of T1, the base current requirements of Q2 and Q4 will increase.

This base current must flow through the primary winding of current transformer T3, pins 1 and 2. When this current is large enough to cause the positive voltage across resistor R5 to exceed the zener voltage of D10, transistor Q5 will be brought into conduction. The positive pulse then generated on Q5 emitter will turn on SCR Q1.

The SCR Q1 is connected directly across control winding pins 7 and 8 of T2, and when Q1 conducts, it will effectively short out this winding. This short will be reflected as a virtual short in all windings of T2. Resistor R1 provides a load for the drive signal during this period and prevents this shorted condition from being reflected back to the Royer oscillator. The main effect of this short is to remove drive power from Q2 and Q4 bases, and to turn these transistors off, and allow the energy in T1 to be transferred to the storage capacitor.

This type of operation prevents the power transistor current ratings from being exceeded and provides inherent isolation of the converter elements from power supply shorts and flashlamp CW malfunctions.

The High Voltage Regulator also controls the power converter, by supplying a positive inhibit signal to Q5 and the SCR Q1 when the desired high voltage has been reached. This signal keeps the SCR on and prevents further voltage conversion. If the storage capacitor bleeds down before the flashlamp has fired, the regulator will sense the voltage drop and remove the inhibit signal until the proper voltage has been restored.

c. High Voltage Regulator (12G0009, Figure E-16). The high voltage regulator senses a sample of the voltage on the energy storage capacitor and produces a +15 volt inhibit signal to stop both power convert modules. It consists of two stages of differential amplification and an output stage.

The high voltage is applied through a 15 megohm resistor in the High Voltage Assembly to pin S of the PC board and the base of Q1. Resistor R1 and the external 50 kilohm voltage adjust potentiometer form the lower portion of this high voltage divider. Q1 and Q2 are a differential amplifier with D1, R5 and R6 forming the voltage reference for amplifier. The input is the HV sample on the base of Q1, and the output is taken from the collector of Q2. This output is applied to a second differential amplifier consisting of Q3 and Q4. The output from the collector of Q4 is applied to an impedance matching transistor Q5.

Transistor Q5 controls the drive transistor Q6. When the input sample of the high voltage has reached the desired level, Q5 is turned on, supplying +15V through isolation diodes D4 and D5 to both power converter modules as an inhibit signal. Due to the very high gain of the two differential amplifiers, the output is driven to +15V almost instaneously as the input voltage on the base of Q1 exceeds the reference voltage on the base of Q2.

d. High Voltage Assembly (12G0010 Figure E-14). The High Voltage Assembly performs the functions of energy storage capacitor dump, high voltage sense, and quench sensing. The

high voltage relay K1 is energized by +24 volts through the transmitter and power supply safety interlock circuit. If this circuit is interrupted by having a cover off or open, or the cavity temperature has exceeded 172°F the relay will de-energize and connect resistors R4 through R7 from the high voltage to ground to discharge the storage capacitor.

Resistor R2 provides the high voltage regulator with a sample of the capacitor voltage as discussed in the preceding section. Resistors R3, R1, R10 and R9 comprise a voltage divider for the negative going pulse coupled through C1 when the flashlamp is fired. This pulse, generated by the sudden drop in the level of the high voltage, is limited in amplitude to the forward voltage drop across series diodes D1, 2, and 3. The pulse is coupled through diode D4 to the quench sense output. It is used in the Low Voltage Regulator Assembly to trigger the quench inhibit multivibrator.

D. MAINTENANCE REQUIREMENTS

1. General Maintenance

This laser system has been designed to be as reliable and maintenance free as possible. To this end, the optical components have been placed in a sealed compartment for dust and humidity protection, the cooling system has been conservatively rated and fabricated from the most inert materials available for each part of the system, and the electronic components have been selected and circuits designed to operate well below maximum ratings with as high a degree of self protection and self limiting as possible. The only items exhibiting wear-out characteristics and therefore requiring periodic or planned maintenance are the flashlamps and the ion exchange resin filter.

The expected life of the flashlamps in this service is over 1 million shots (30 hours run time @ 10 pps). The average lamp experiences a "burn-in" during the first few thousand shots. During this period the laser output can be expected to decrease. The pump input should be increased just sufficiently to restore the laser output to specified levels. After this initial burn-in, the laser output will remain constant for most of the lamp's life. When the lamps near their end-of-life point, it will again require increases in pump input energy to maintain the laser output. The lamps must be replaced when pumping requirements approach the capacity of the power supply. (See Section A).

Although exact empirical data on the life of the ion-exchange resin filter has not yet been compiled, experience has shown annual replacement to be satisfactory. The resins used have been selected for higher than normal temperature tolerance. These resins will not degrade in a glycol-water solution at temperatures up to 180°F. The recommended replacement rate is annually, or at flashlamp replacement, whichever occurs first.

Since the optical elements are in a sealed compartment within the transmitter, periodic cleaning is not recommended. In fact, it is recommended that the covers be removed only when necessary, as evidenced by a lowered output of the laser.

2. Optical Maintenance

a. Complete Alignment

Every effort has been made to assure that the optical elements of the laser system will maintain their alignment over long periods of time. The mounts chosen for each element have been proven to be very shock and vibration resistant, and the Q-switching system utilized has been selected for its tolerance to misalignment. For these reasons, a complete re-alignment should not be required unless an accidental event has either severely misaligned the system or damaged an element necessitating replacement. Optical element damage has never occurred due to misalignment errors on the transmitter. The function of the complete optical alignment procedure is twofold: (1) To set all optical surfaces parallel to each other and at right angles to the laser energy path, and (2) To assure the beam path is not vignetted or obstructed. The beam path and size is dictated by the only non-adjustable element in the interferometer - the laser rod. There are many methods of accomplishing this. The method chosen will be largely dependent on the facilities and equipment available. The following procedure requires a minimum of equipment and time, but is by no means the only method to accomplish the objectives. If a different method is preferred, it may be used as long as it fulfills the alignment requirements outlined below.

The equipment required to perform the complete optical alignment procedure consists of:

a. Helium-Neon gas laser.

b. Small front-surfaced mirror. (approximately 1" x 3")

c. Lab stand and clamp for holding the mirror in the interferometer.

d. Lab jack or holder for the HeNe Laser that may be adjusted in height.

Remove the cover from the transmitter. There will be less danger of inadvertent movement of the transmitter if it is placed on a high friction surface, such as a rubber mat, clamped to the bench, or temporarily taped to the work surface with masking tape.

a. Punch a small hole (.1")in the center of a piece of white card stock, 3 x 5 inches or larger.

WARNING NEVER LOOK DIRECTLY DOWN THE LASER BEAM. EYE DAMAGE MAY RESULT.

b. Affix this card to the face (output) of the helium-neon laser so that the laser beam exits through the center of the aperture. This card then becomes the target for the reflections from the optical surfaces in the interferometer.

NOTE: Best alignment is achieved when the distance between the helium-neon laser and the folding prism is greater than four feet.

c. Position the helium-neon laser so that its beam passes through the side port, and the beam splitter onto the folding prism. Insert a negative lens or beam expanding telescope into the laser beam so that the beam is expanded to approximately the diameter of the laser rod when it reaches the folding prism.

d. Align the laser beam through the folding prism and the laser rod such that the beam passes through the center of both faces of the laser rod. Adjust the position of the laser beam so that the reflected spot from the rod surface falls on the white card very close to the hole. (The rod reflection can be identified by inserting a card between the rod and the 85% mirror. The spot that disappears is the reflection from the laser rod. When centering the beam on the rod faces, beam positioning can be simplified by placing a piece of paper over the rod face.

e. Rotate the Q-switch mirror until the laser beam reflects back from the retro prism onto the card near the rod reflection. (Insert a soft shim between the Q-switch rotor and motor to hold the Q-switch mirror in position).

f. Loosen the Q-switch motor clamp and adjust the motor height until the gas laser beam strikes the center of the retro prism roof line and the retro prism reflection is centered on the rod reflection near the hole in the card.

g. The final adjustment of the roof line is made while slowly inserting a piece of paper into the gas laser beam and watching for the retro prism reflection onto the card to completely disappear at the same instant the main beam is completely cut off. If the roof line height is not adjusted properly, its image will disappear either before or after the main beam is completely cut off.

h. Place a front surface mirror at a 45° angle between the laser rod and the Q-switch assembly and remove the negative lens from between the gas laser and the NC-10/80.

i. Position the gas laser so that its output beam is folded onto the surface of the laser rod by the front surfaced mirror. Adjust the beam so that the reflection from the surface of the laser rod returns near to the hole in the card. (In order to identify the rod reflection, place a card between the rod and the 85% mirror. The light spot that remains on the card is the rod reflection.

j. Remove the card between the rod and the 85% mirror and align the mirror to superimpose its reflection onto the rod reflection. (Unfortunately two reflections are produced by the exit mirror -input face and output face. The input face reflection is to be superimposed on the rod reflection, but can only be identified by aligning one and then the other, using the mirror reflection which results in lasing when the calibrator is operated.

b. Optical Cleaning

CAUTION ALL GLASS ELEMENTS ARE PRECISION, DIELECTRICALLY COATED, OPTICAL COMPONENTS, AND SHOULD BE HANDLED ONLY BE TRAINED PERSONNEL.

The laser interferometer is contained in a sealed chamber to prevent dust, humidity, or condensation from settling on the optical components. However, it is possible for dust or moisture to accumulate during periods when the chamber is open for maintenance. If dust or a deposited film is present, laser output will be reduced and a hazard to the optical elements is created. Dust particles on the optics will absorb the laser energy or become focal points which may pit the surfaces.

Before the sealed chamber is closed, it is advisable to blow off all dust using a clean dry, gas jet. Inspect all surfaces with a high intensity light and an eye loupe. If cleaning is required to remove a film, use a dilute Aerosol solution in distilled water. Apply the solution with a barely moistened optical swab and dry with another swab. If repeated cleanings are necessary, use fresh swabs for each operation.

c. Cooling System Maintenance

The cooling system is filled through the reservoir port. Using a small funnel or a wash bottle, fill the reservoir with the transmitter tilted so that the fill port is the highest part of the cooling system. Cap the reservoir, momentarily run the pump, and repeat the process. Tip the transmitter in all planes to work the air bubbles into the reservoir. Continue until all air is removed from the system.

d. Ion Exchange Filter Replacement

To replace the ion-exchange reservoir, remove the transmitter case and drain the reservoir (not the entire cooling system, unless a complete coolant change is desired). Disconnect the ion-exchanger filter hose, remove the retaining ring, and pull the filter cartridge out.

CAUTION THE HOSE FITTING IS PLASTIC AND WILL NOT WITHSTAND HEAVY TENSION. . IF THE CARTRIDGE DOES NOT PULL EASILY, REMOVE THE FITTING AND REPLACE IT WITH 1/8" PIPE TO EXTRACT THE CARTRIDGE.

Install the new cartridge in reverse order, making certain the 0-ring is properly seated in its retaining groove. Reconnect the hose fitting, hose, and refill the cooling system with reagent grade ethylene glycol and distilled, deionized water.

3. Troubleshooting Procedure

A malfunction in the laser system is generally evidenced by a failure to operate: a failure to operate properly: or an out-of-tolerance laser output. This troubleshooting guide (Table 1) will assist in locating malfunctions. Neither the symptoms nor the probable causes are listed in order of probability of occurrence.

PAGES D-6 THROUGH D-11 DELETED

TABLE I
TROUBLESHOOTING GUIDE

	Sympton	Probable Cause	Action
1.	CB-1 trips when turned on.	Primary power polarity incorrect.	Replace CR3 in power supply. Reconnect primary power correctly.
2.	Operate lamp comes on when when CB-1 is turned on.	Relay K1 contacts stuck. Remote control on.	Free relay, replace if necessary. Disconnect remote cable.
3.	Unit will not turn on when operate switch is activated.	Local-remote switch in remote position. Primary power voltage too low.	Turn to local position, or activate remotely. Check and correct.
4.	CB-1 trips when operate switch is activated.	a. C1 shorted. b. Short in printed circuit assembly. Remove cards until short is localized. c. Short in transmitter.	a. Replace. b. Isolate short and replace/ repair defective component. c. Disconnect umbilical cable from transmitter-isolate short and repair.

Symptoms	Probable Cause	Action
5. Q-motor runs, but laser does not fire at any rep rate.	a. Interlock circuit open. b. No high voltage. c. No trigger voltage. d. No SCR trigger. e. No high voltage trigger. f. No synchronizing pulse.	a. Close covers, check interlocks. b. Check power conversion circuits. c. Check low voltage regulator. d. Check GP-200 synchronizer. e. Check GP-400 trigger generator. f. Check magnetic pick-up, adjust proximity to Q-switch if required.
6. Q-motor does not run.	a. Motor drive missing. b. Phasing capacitor failure. c. Motor not free to rotate. d. Motor winding failure.	a. Check GP-100 motor driver-repair. b. Check GP-400 assembly. c. Check for armature freedom. d. Replace motor.
7. Unit will not operate from remote position.	a. Input power off. b. Local-remote switch in local position. c. Open in remote box. d. Open in control lines.	a. Check and correct. b. Check and correct. c. Verify by shorting connections at remote box. Repair remote box. d. Verify by shorting connections at power supply. Repair control lines.
8. Unit will not shut off.	See Item 2.	

Symptoms	Probable Cause	Action
9. Unit will not run at all rep rates, but will operate at some.	a. GP-200, A205, or A206 defective.	a. Replace
	b. Switch S1 or cabling defective.	b. Locate and repair fault.
10. Unit operates at rep rate but will not single shot.	a. Single shot control.	a. Check GP-200, A201.
	b. Cabling or switch.	b. Check and repair.
11. Q-motor not operating at synchronous speed.	a. Current limiter malfunction.	a. Check GP-100-Q112, A101, A102.
	b. Incorrect drive to bridge.	b. Check GP-100-A101, A102, Q104, Q105, Q108, Q109.
	c. Oscillator input incorrect.	c. Check GP-100-oscillator, Q111.
	d. Power bridge open.	d. Check GP-100-Q102, Q103, Q016, Q107, CR101, CR102.
	e. Primary power below 22V.	e. Check and correct.
12. High voltage missing.	a. 15V regulator inoperative.	a. Check 12G0007-Q1,2,4,5,6.
	b. No converter drive.	b. Check 12G0007-Q6, Q7, D10, D11, T1.
	c. Malfunction in power converter.	c. Check 12G0013-Q1, Q5, D1, T2, D3, D10, Q2, Q4, D8.
	d. Regulator malfunction.	d. Check 12G0009 and H.V. adjust potentiometer R1 in power supply for open.
	e. Dump relay inoperative.	e. Check 12G0010-K1.
	f. H.V. line shorted.	f. Open H.V. line from 12G0010 to energy storage capacitor.

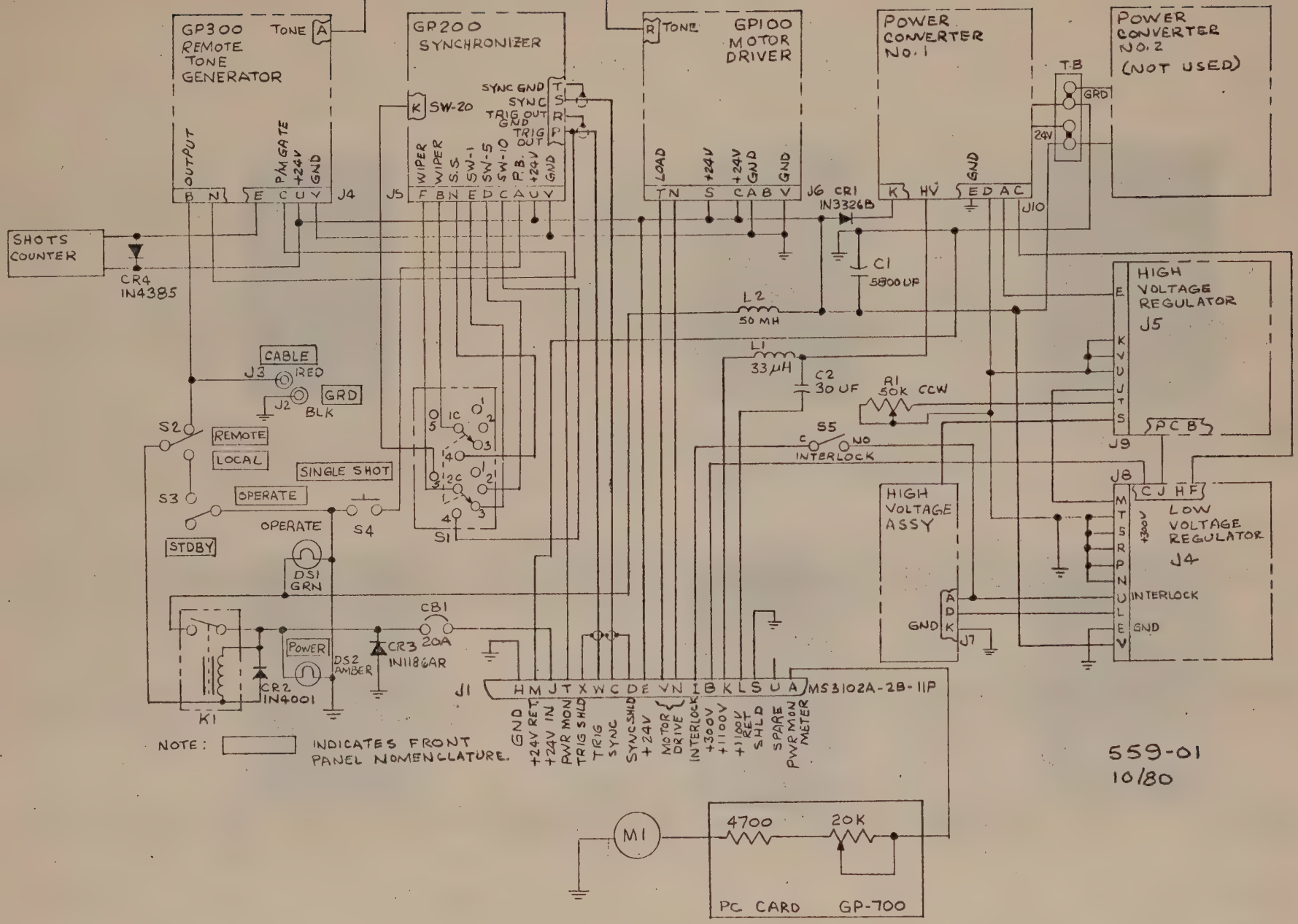
Symptoms	Probable Cause	Action
13. High voltage low, or capacitor charging too slow.	a. Requirements exceed supply capability.	a. Maximum output is approximately 1100 volts-reduce requirement.
	b. Primary power too low.	b. Check voltage and current capability of primary power.
	c. H.V. regulator malfunction.	c. See item 11d - also check R1 in 12G0009.
	d. Power converter malfunction.	d. See item 11c - also check R5 in 12G0013.
	e. H.V. sensing incorrect.	e. Check R2 - 12G0010.
14. Laser output indicates low.	Verify with independent power check. If true, see step 15. If false:	
	a. Power monitor failure.	a. Check GP-500.
	b. Power indicator failure.	b. Check indicator lamp/meter.
	c. Calibration change.	c. Reset GP-500, R508 or R523 or R3 in transmitter.
15. Laser output is low.	a. Insufficient pump.	a. Increase pump voltage by adjusting R1 in power supply CW.
	b. Lamp reached end of life.	b. Replace lamp, see Section D-2 - C-1.
	c. Optical elements dirty.	c. Clean optics. CAUTION: See Section D-2-6.
	d. Optics misaligned.	d. Realign interferometer - see Section D-2.
	e. Cavity insert reflectors contaminated.	e. Clean cavity inserts - see Section D-2.
	f. Output beam obstructed by external test equipment.	f. Check light path through test set-up with image converter.
	g. Flashlamp timing off.	g. Adjust magnetic sync pick-up for optimum.

Symptoms	Probable Cause	Action
15. CONTINUED	h. Q-motor not running at sync speed.	h. See item 11.
	i. High voltage is low.	i. See item 13.
16. Laser output varies in amplitude.	a. High voltage not regulating.	a. See item 13.
	b. Q-motor not running at sync speed.	b. See item 11.
	c. Flashlamp timing incorrect.	c. See item 15g.
	d. Q-motor bearings worn.	d. Check, replace motor if required.
	e. Insufficient pump.	e. Increase pump. See item 15a.
17. Laser output varies in time (pulse-to-pulse jitter.)	a. Synchronizer erratic.	a. Check GP-200 circuits.
	b. Q-motor not synchronized.	b. See item 11.
	c. Q-motor bearings worn.	c. Replace Q-motor if required.
18. Laser double pulses.	a. Over pumped.	a. Reduce flashlamp pump. If power is low, see items 15b, d, e, g, and h.
19. Output power falls as unit runs.	a. Coolant pump not operating.	a. Check, repair or replace.
	b. Insufficient coolant.	b. Repair leak, replace coolant. see Section D-3.
	c. Overpumped.	c. Check for double pulsing, see item 18.

Symptoms	Probable Cause	Action
20. Remote power indicator inoperative.	a. Power below threshold.	a. See item 15.
	b. Power monitor inoperative.	b. See item 14.
	c. Remote gating circuit inoperative.	c. Check GP-300 - Q301-303.
	d. Remote lines open.	d. Verify laser on-off remote control.
	e. Remote speaker open.	e. Check and replace.
21. Shots counter inoperative.	a. Drive circuit inoperative.	a. Check GP-300.
	b. Mechanical counter failure.	b. Check counter, replace.

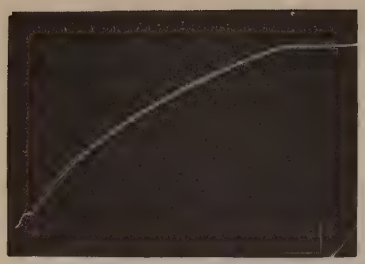
E. SCHEMATIC DIAGRAMS AND MAINTENANCE DATA

All schematic diagrams, parts locations, and waveforms have been grouped in this section. This section may be removed in its entirety for shop use.

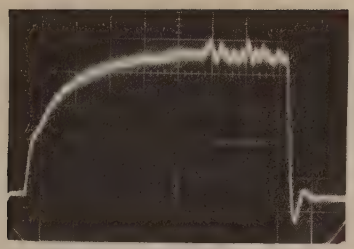


E-2

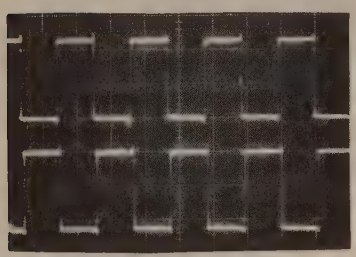
FIGURE E-1. POWER SUPPLY SCHEMATIC



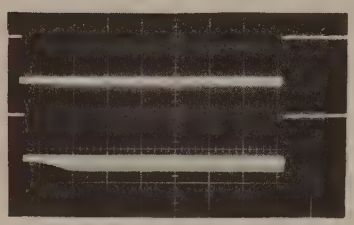
High Voltage Charging
Vert: 200V/cm
Horiz: 10 ms/cm
Location: C2



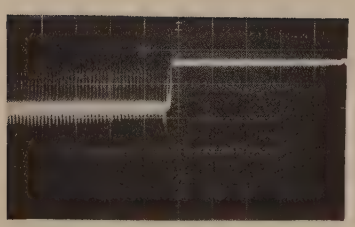
Input Current
Vert: 5 Amp/cm
Horiz: 10 ms/cm
Location: 25 Amp, 50mV
shunt in primary line



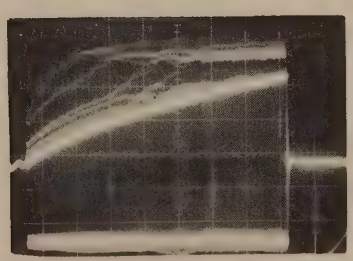
Converter Drive
Vert: 10V/cm
Horiz: 50 us/cm
Location: Top - J8-H
Bottom- J8-F



Regulator output
Vert: 10V/cm
Horiz: 10 ms/cm
Location: Top - J9-D
Bottom- J9-E



Quench output
Vert: 1 V/cm
Horiz: 1.0 ms/cm
Location: J8-M



Pwr Transistor Collect.
Vert: 10 V/cm
Horiz: 10 ms/cm
Location: 12G0013, Q2
Collector

Fig. E-2 Power Converter Wave Forms.

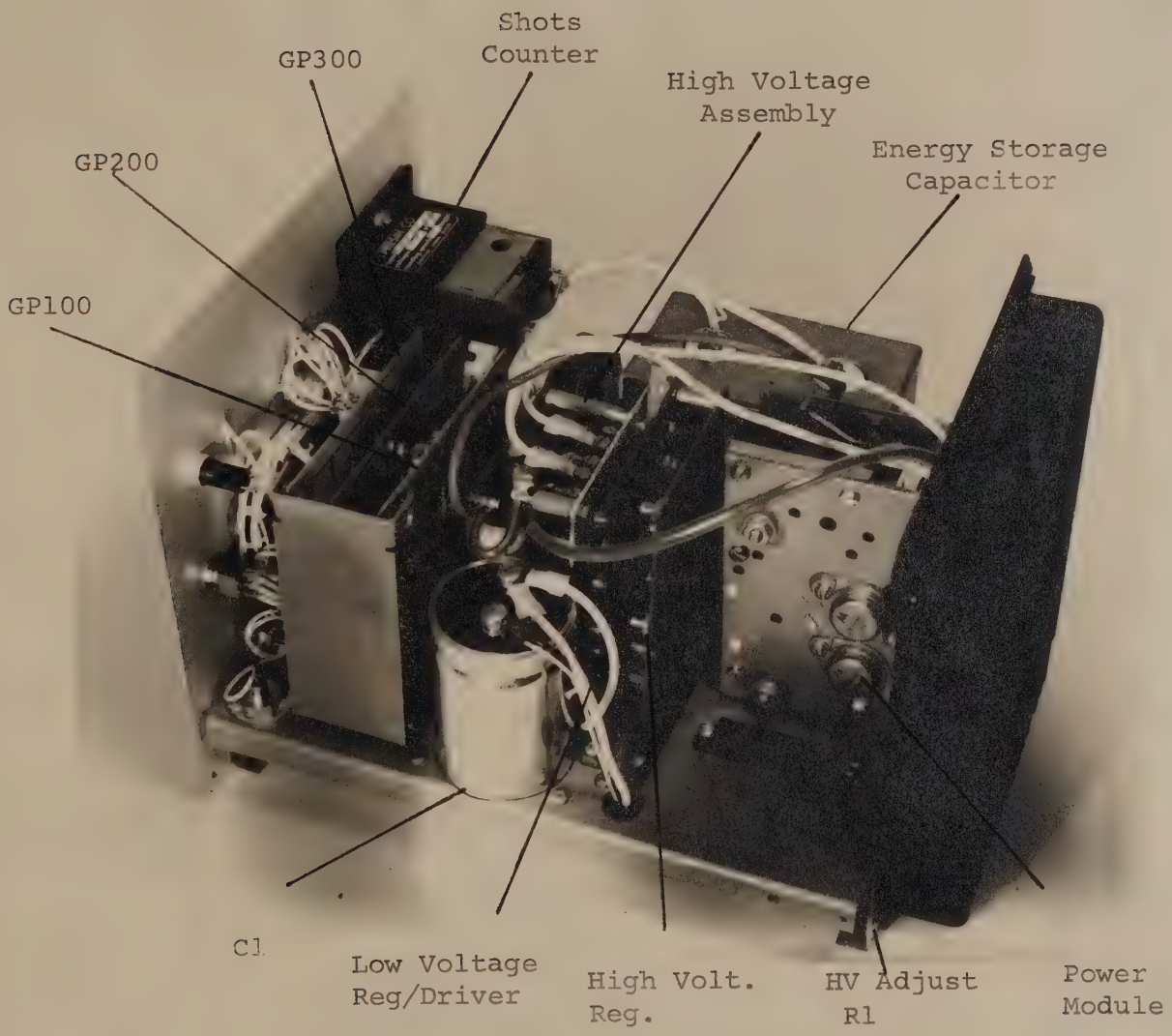


Figure E-3 Power Supply Assembly

PHOTOGRAPH COURTESY
INTERNATIONAL LASER SYSTEMS, INC.
3404 N. ORANGE BLOSSOM TRAIL
ORLANDO, FLORIDA 32804
(305) 295-[illegible]

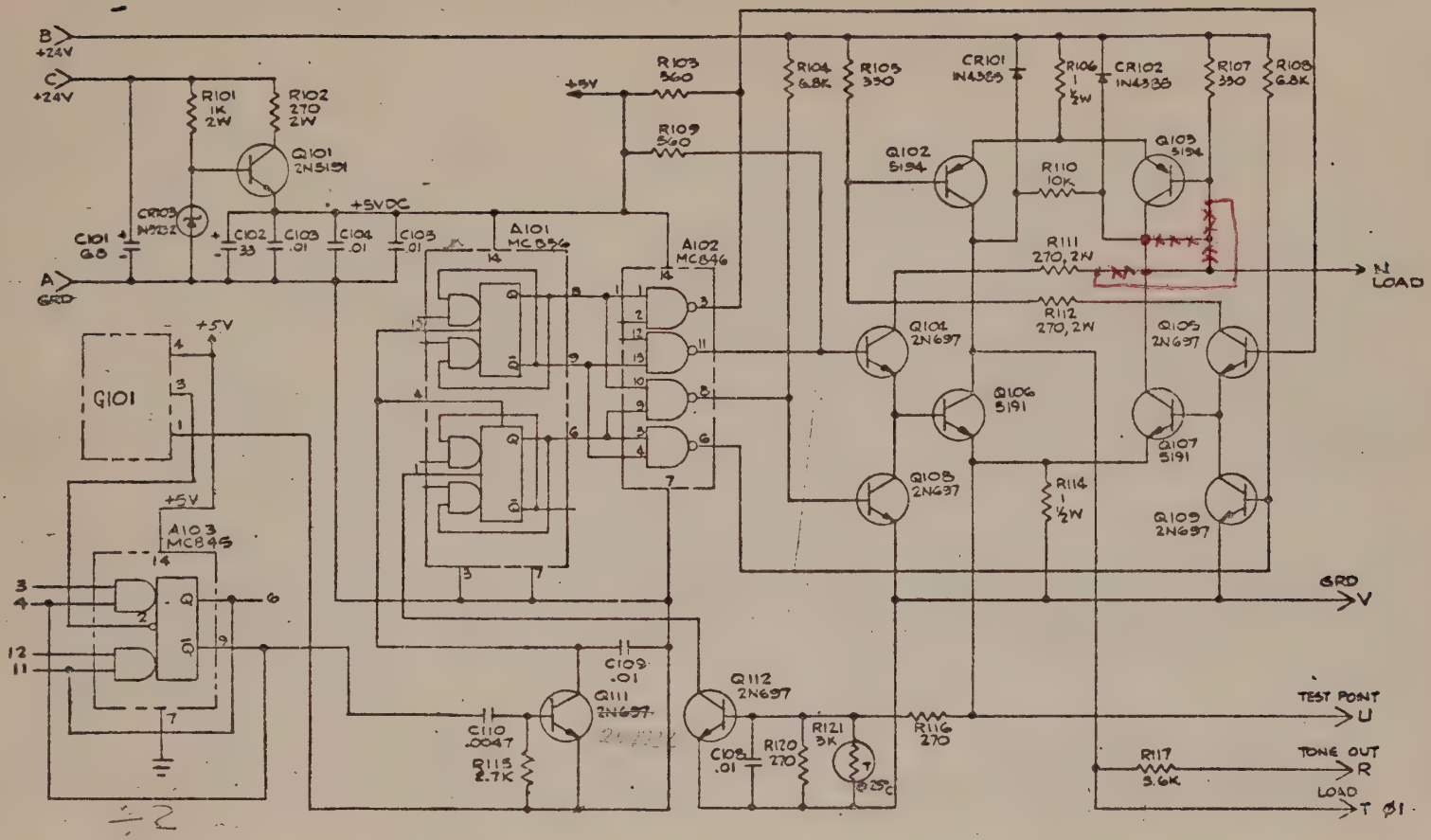


Figure E-4
GP-100 Motor Driver Schematic Diagram

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS, ¼W ±5%
   ALL CAPACITORS ARE IN MICROFARADS (MF)

LAST DESIGNATION	
RESISTOR	R121
CAPACITOR	C110
DIODE	CR103
TRANSISTOR	Q112
INTEGRATED CKT	A103
RELAY	K101

QTY REQD	ITEM	PART NUMBER	SYM	DESCRIPTION	CODE IDENT NO	MATERIAL AND SPECIFICATIONS
← ASSY		LIST OF PARTS				

TOLERANCE UNLESS SPECIFIED .x ±, .xx ±, .xxx ±, ANGLES ±
RMS FINISH √
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION
DASH NO | QTY REQD

SIGNATURES | DATES
DRAFTSMAN 5-31-71
CHECKER
APPD
APPD
ILS APPD
CUSTOMER APPD

INTERNATIONAL LASER SYSTEMS
ORLANDO, FLORIDA

TITLE: MOTOR DRIVER DIAGRAM, 400 - I

SIZE | CODE IDENT NO | DRAWING NO: 1001443
SCALE ~ | SHEET 3?

Figure E-5 Deleted

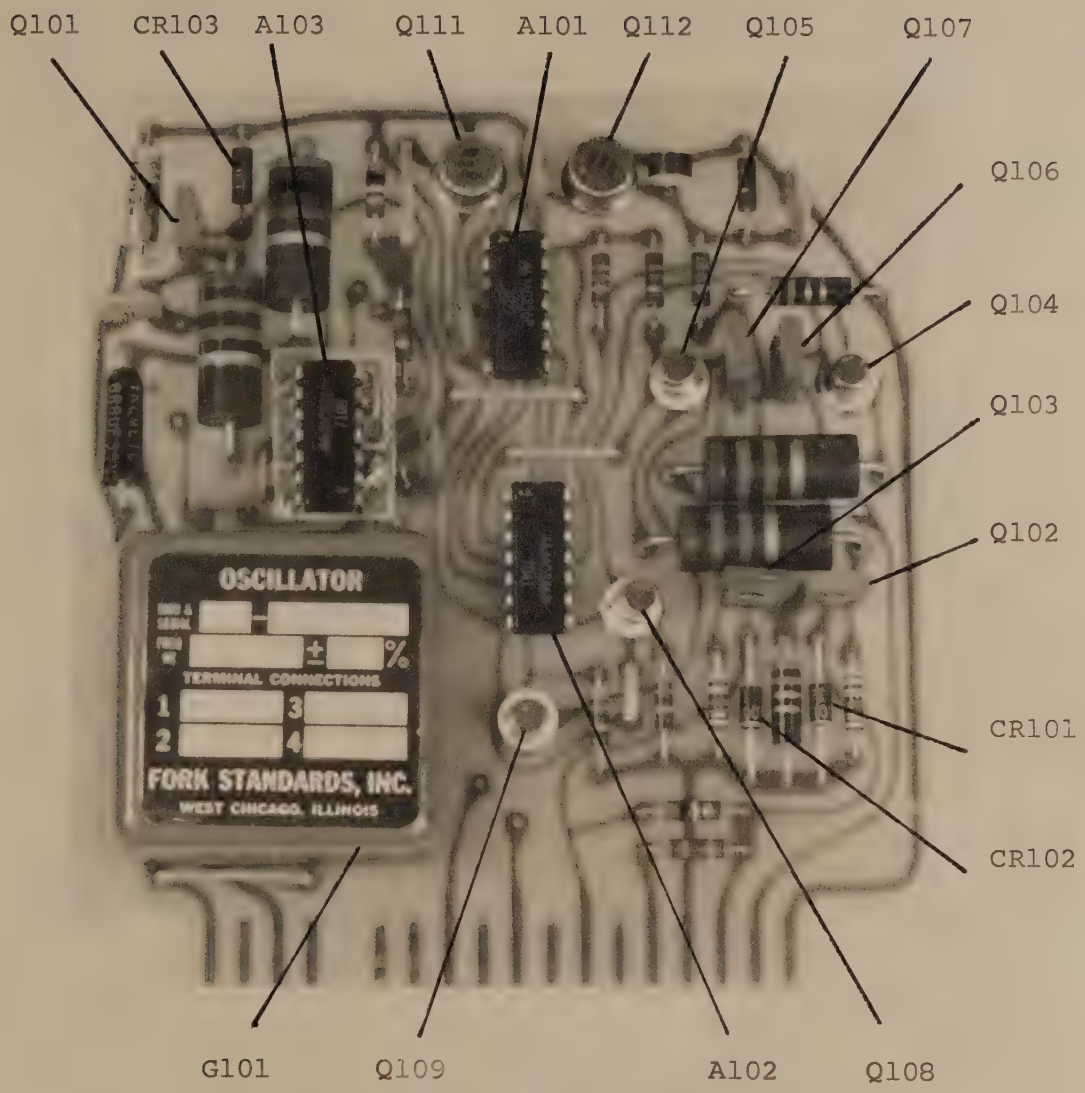


Figure E-6. GP-100 Motor Driver Assembly

PHOTOGRAPH COURTESY
INTERNATIONAL LASER SYSTEMS, INC.
3404 N. ORANGE BLOSSOM TRAIL
ORLANDO, FLORIDA 32804
(305) 295-4010

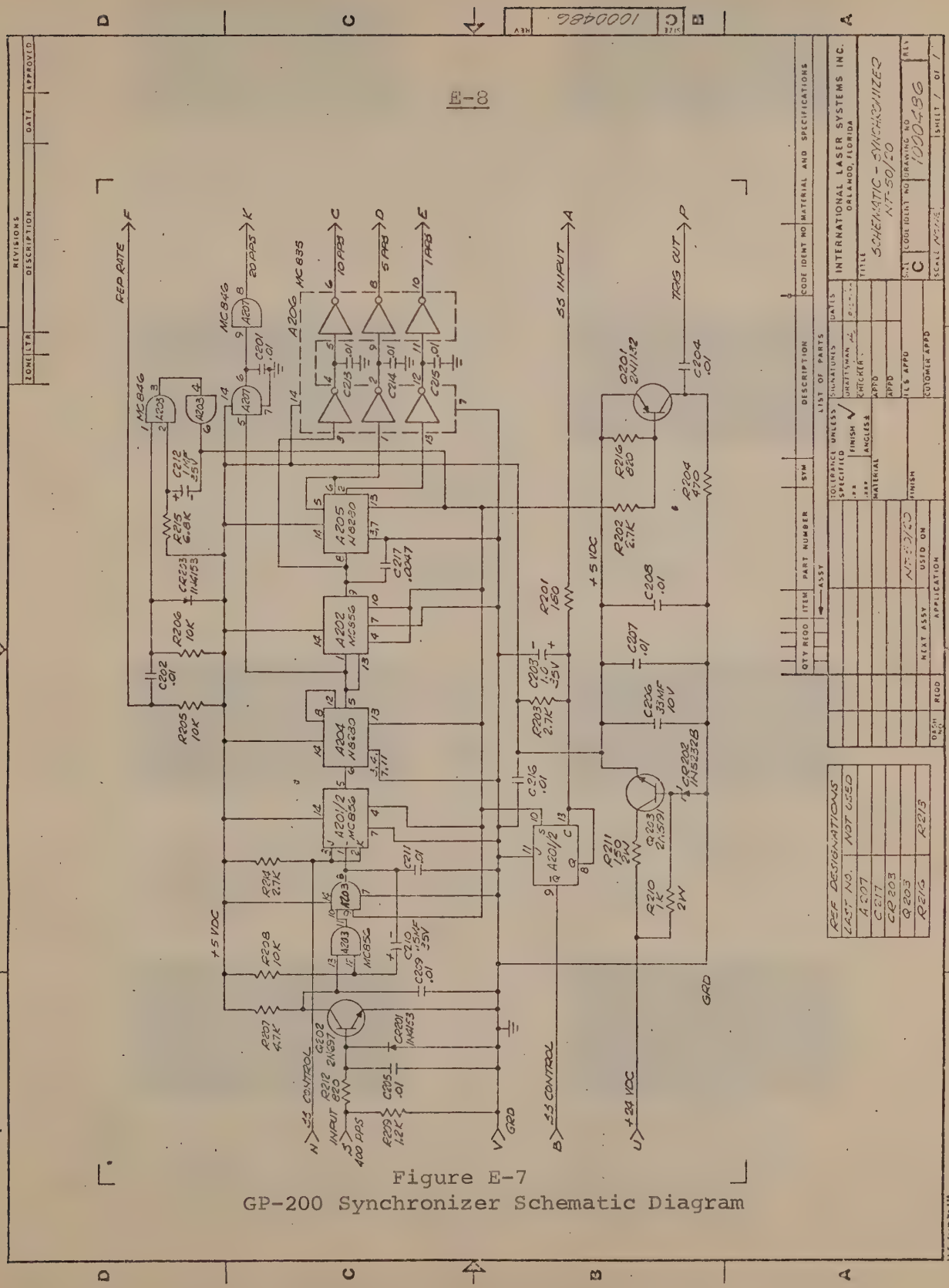
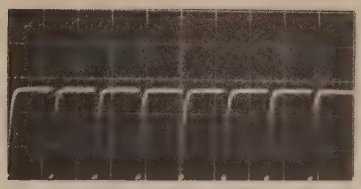
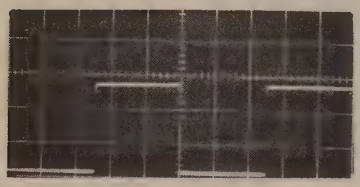


Figure E-7
GP-200 Synchronizer Schematic Diagram

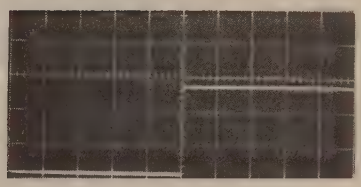
Vert: 2V/cm
Horiz: lms/cm
Location: Q202 Col.



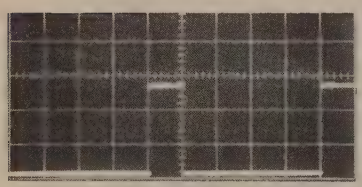
Vert: 2V/cm
Horiz: 1 ms/cm
Location: A203-8



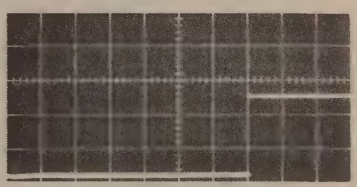
Vert: 2 V/cm
Horiz: 20 ms/cm
Location: A206-6
Rep Rate: 10pps



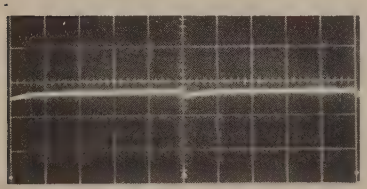
Vert: 2 V/cm
Horiz: 20 ms/cm
Location: A206-8
Rep Rate: 5 pps



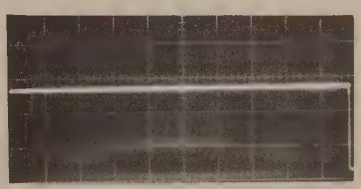
Vert: 2V/cm
Horiz: .2 sec/cm
Location: A206-10
Rep Rate: 1pps



Vert: 2 V/cm
Horiz: .1 ms/cm
Location: A203-6
Rep Rate: 10pps

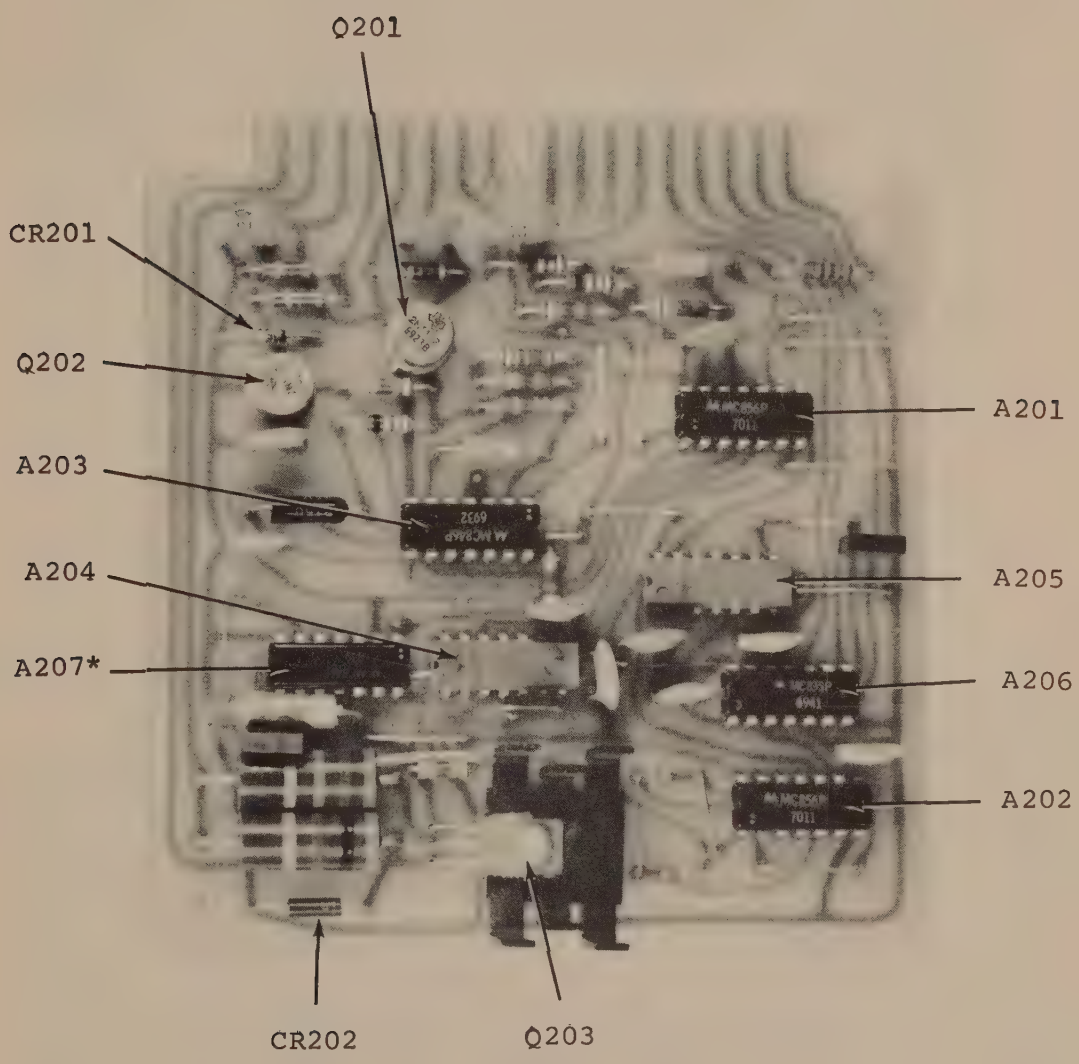


Vert: 2 V/cm
Horiz: 20 ms/cm
Location: A203-6
Rep Rate: 10pps



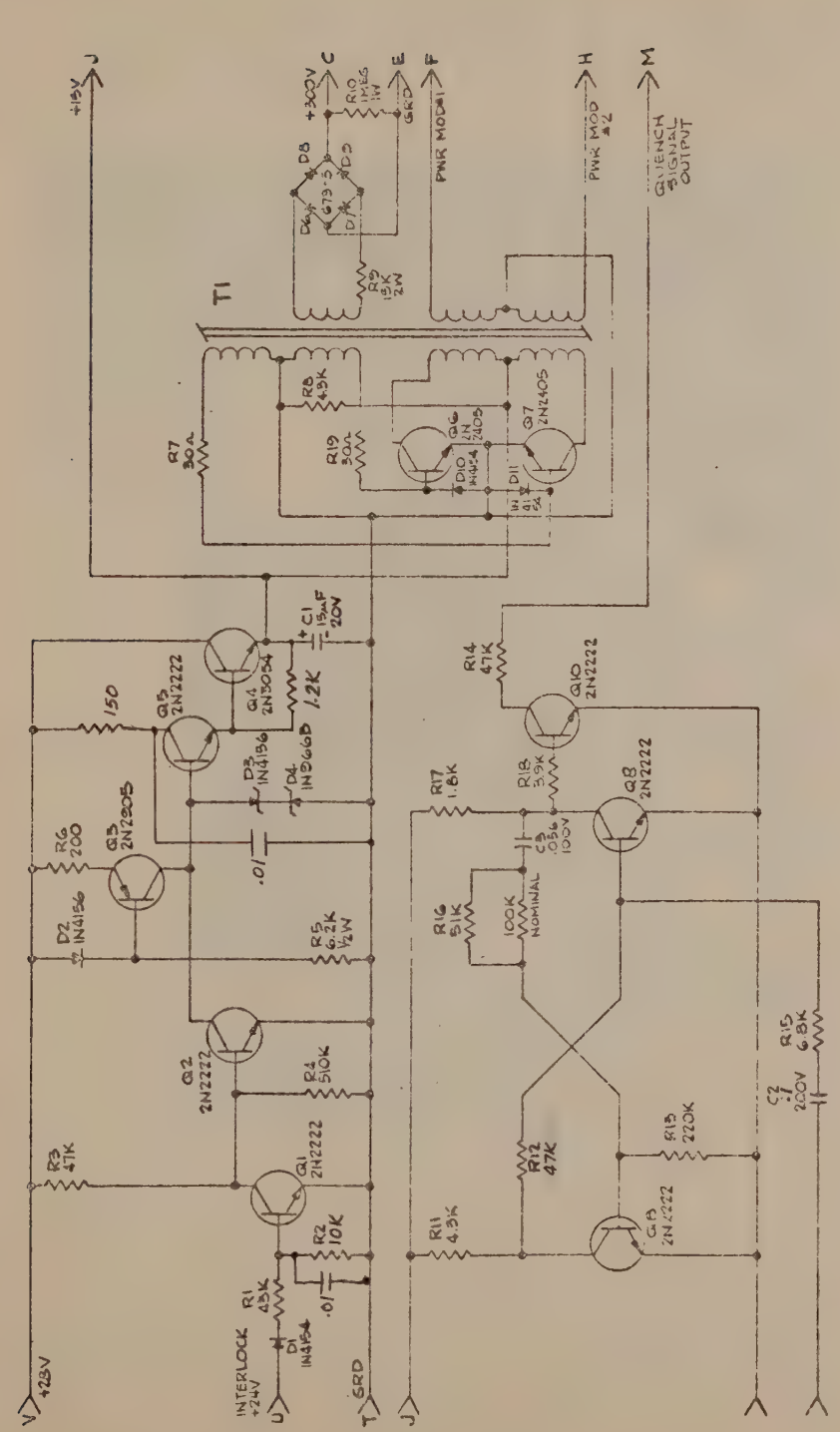
Vert: 2 V/cm
Horiz: 10 ms/cm
Location: A203-6
Rep Rate: SS
Sync: A201-9

Figure E-8, GP200 Synchronizer Waveforms



* Used with 20 pps only

Figure E-9, GP-200 Synchronizer Assembly



LOW VOLTAGE & DRIVER SCHEMATIC
FIGURE

LAST DESIGNATION	
RESISTOR	R19
CAPACITOR	C3
DIODE	D11
TRANSISTOR	Q10
TRANSFORMER	T1

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, ¼W, ±5%
ALL CAPACITORS ARE IN MICROFARADS (MF)

Figure E-10
Low Voltage Regulator Schematic Diagram

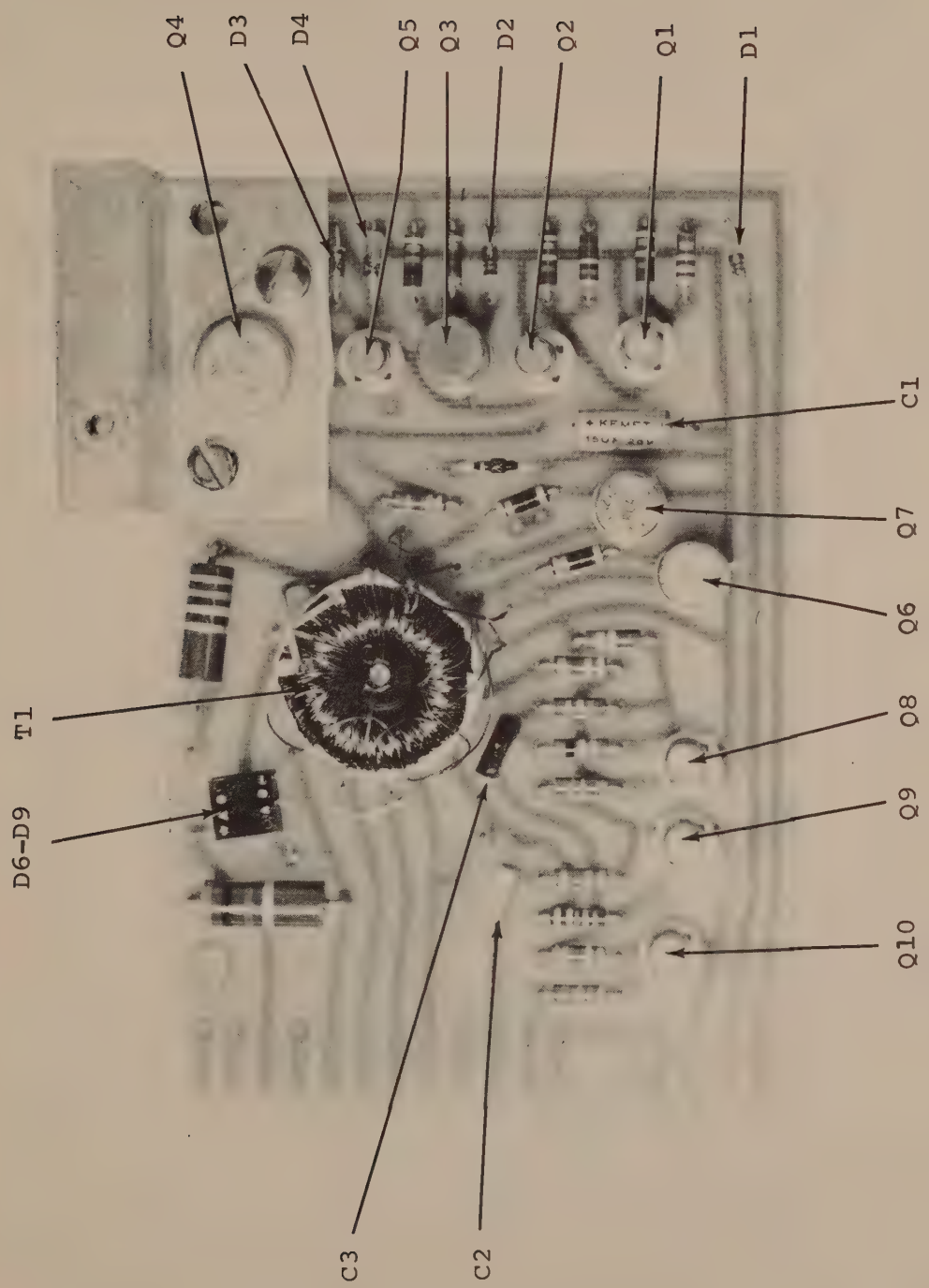
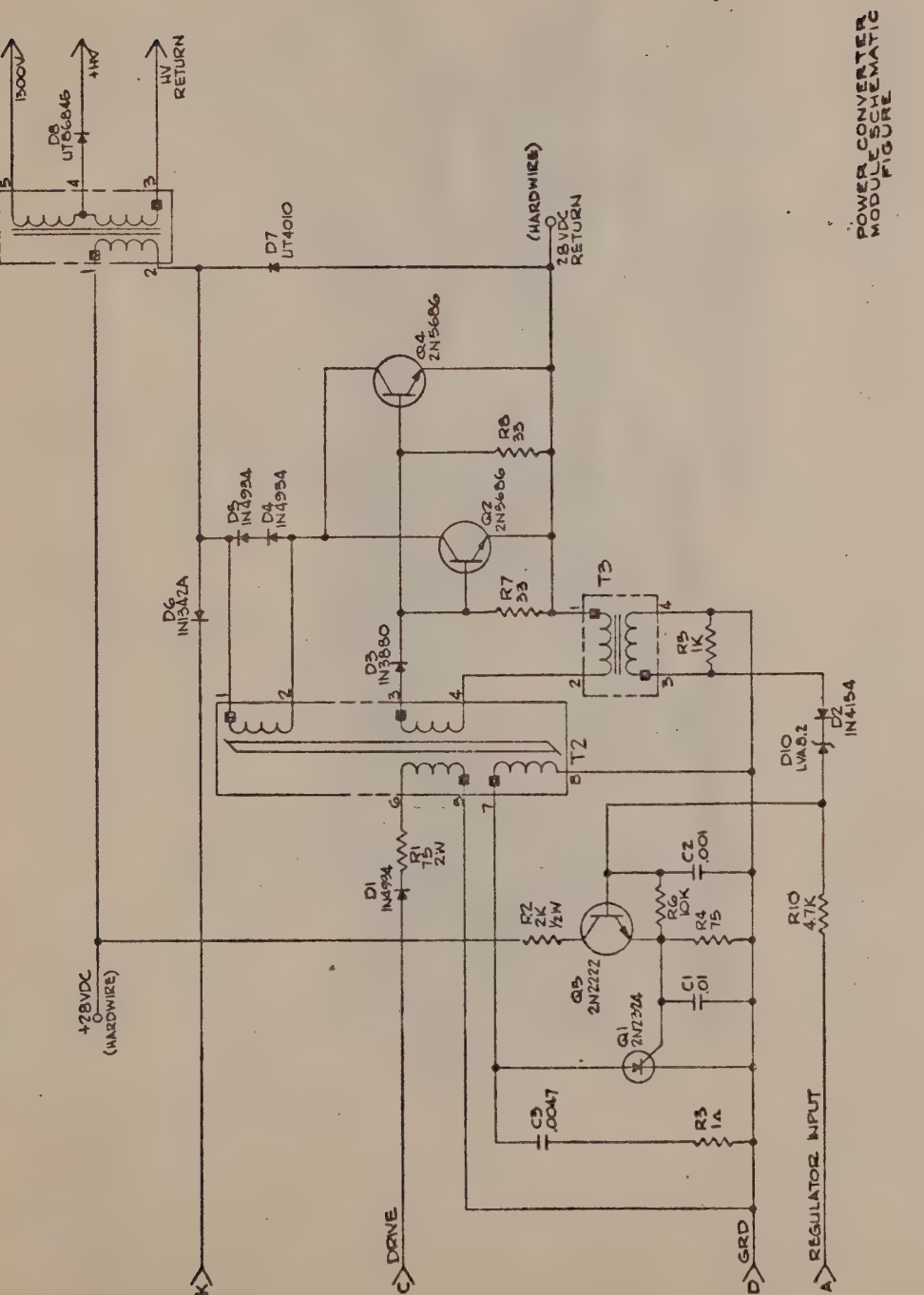


Figure E-11, Low Voltage Regulator Assembly



POWER CONVERTER MODULE SCHEMATIC FIGURE

LAST DESIGNATION
RESISTOR R10
CAPACITOR C3
DIODE D10
TRANSISTOR Q5
TRANSFORMER T3

NOTES:
1. UNLESS OTHERWISE SPECIFIED
ALL RESISTORS ARE IN OHMS, ¼W ±5%
ALL CAPACITORS ARE IN MICROFARADS

Figure E-12
Power Converter Module Schematic Diagram

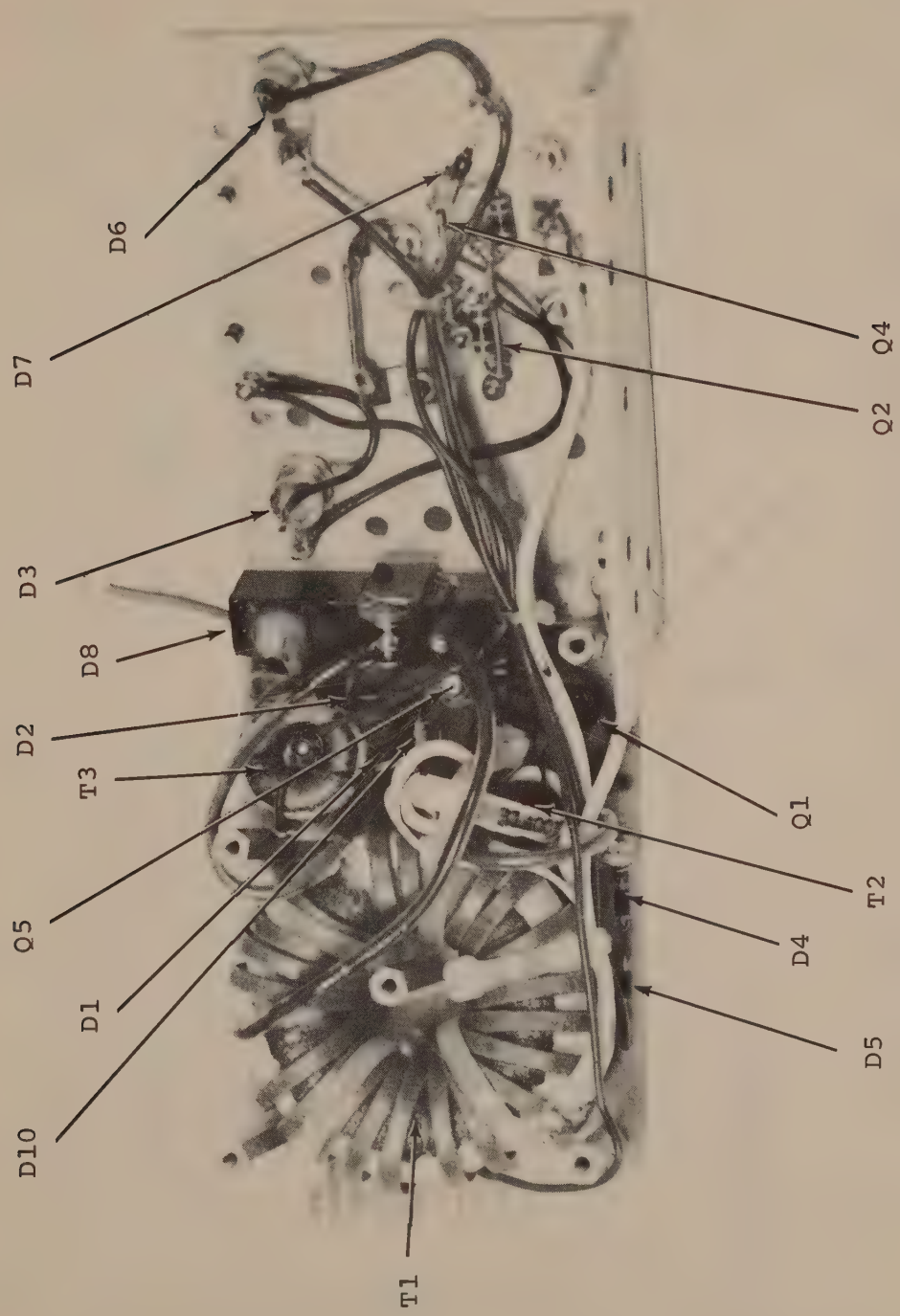


Figure E-13, Power Converter Module Assembly

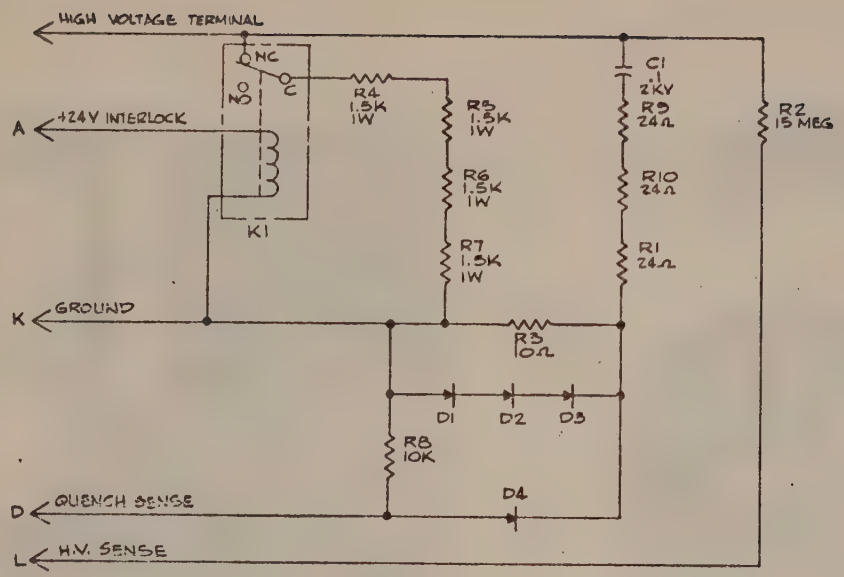


Figure E-14
High Voltage Assembly Schematic Diagram

NOTES:

1. UNLESS OTHERWISE SPECIFIED
   ALL RESISTANCE IS IN OHMS, 1/4 W, ±5%
   ALL CAPACITANCE IS IN MICROFARADS (μF)

LAST DESIGNATION	
RESISTOR	R10
CAPACITOR	C1
DIODE	D4
RELAY	K1

QTY REQD	ITEM	PART NUMBER	SYM	DESCRIPTION	CODE IDENT NO	MATERIAL AND SPECIFICATIONS
	ASSY			LIST OF PARTS		

TOLERANCE UNLESS SPECIFIED .xx — FINISH ✓ .xxx — ANGLES ±

MATERIAL —

FINISH —

SIGNATURES	DATES
DRAFTSMAN	12-11-69
CHECKER	
APPD	
APPD	
I L S APPD	
CUTOMER APPD	

INTERNATIONAL LASER SYSTEMS INC
ORLANDO, FLORIDA

TITLE SCHEMATIC DIAGRAM-HIGH VOLTAGE ASSEMBLY

SIZE C | CODE IDENT NO | DRAWING NO | REV

SCALE — | SHEET | OF

DASH NO	REQD	NEXT ASSY	USED ON
		APPLICATION	

I L S Form No 118

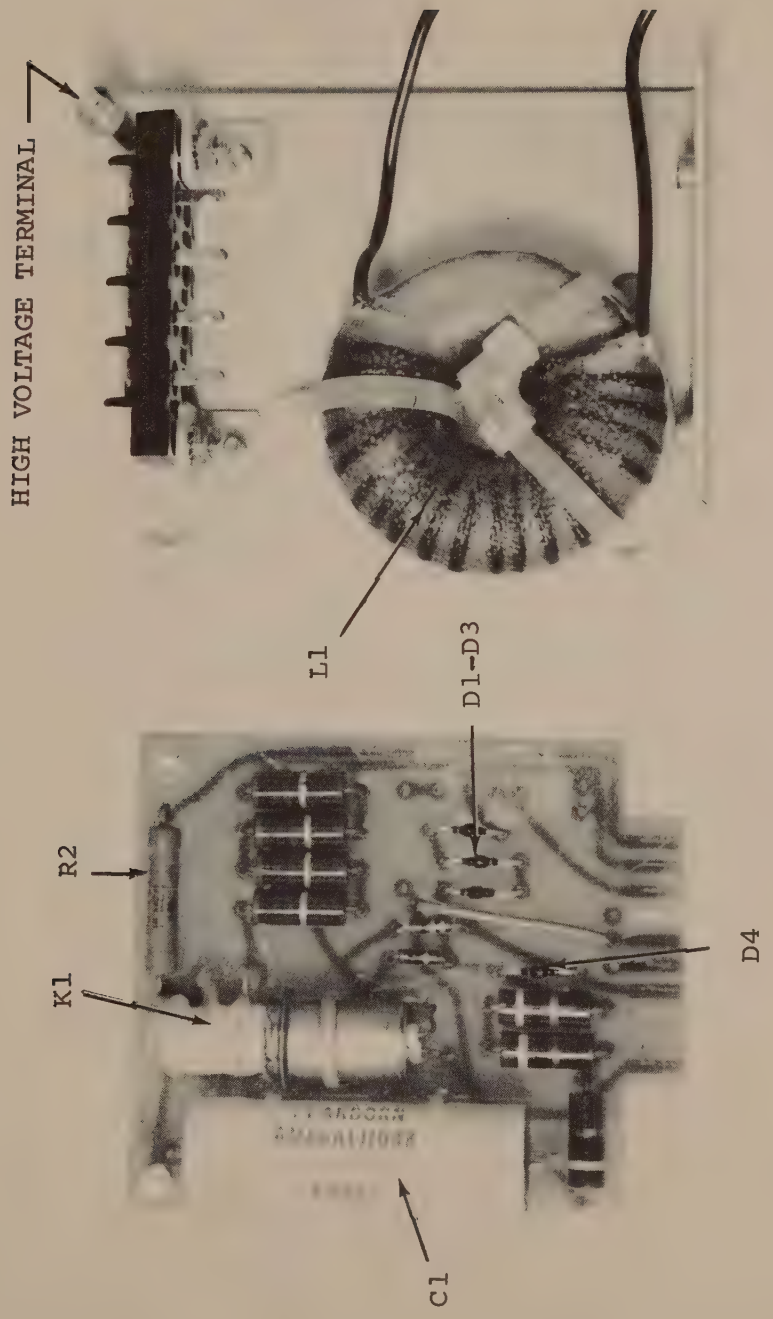


Figure E-15, High Voltage Assembly

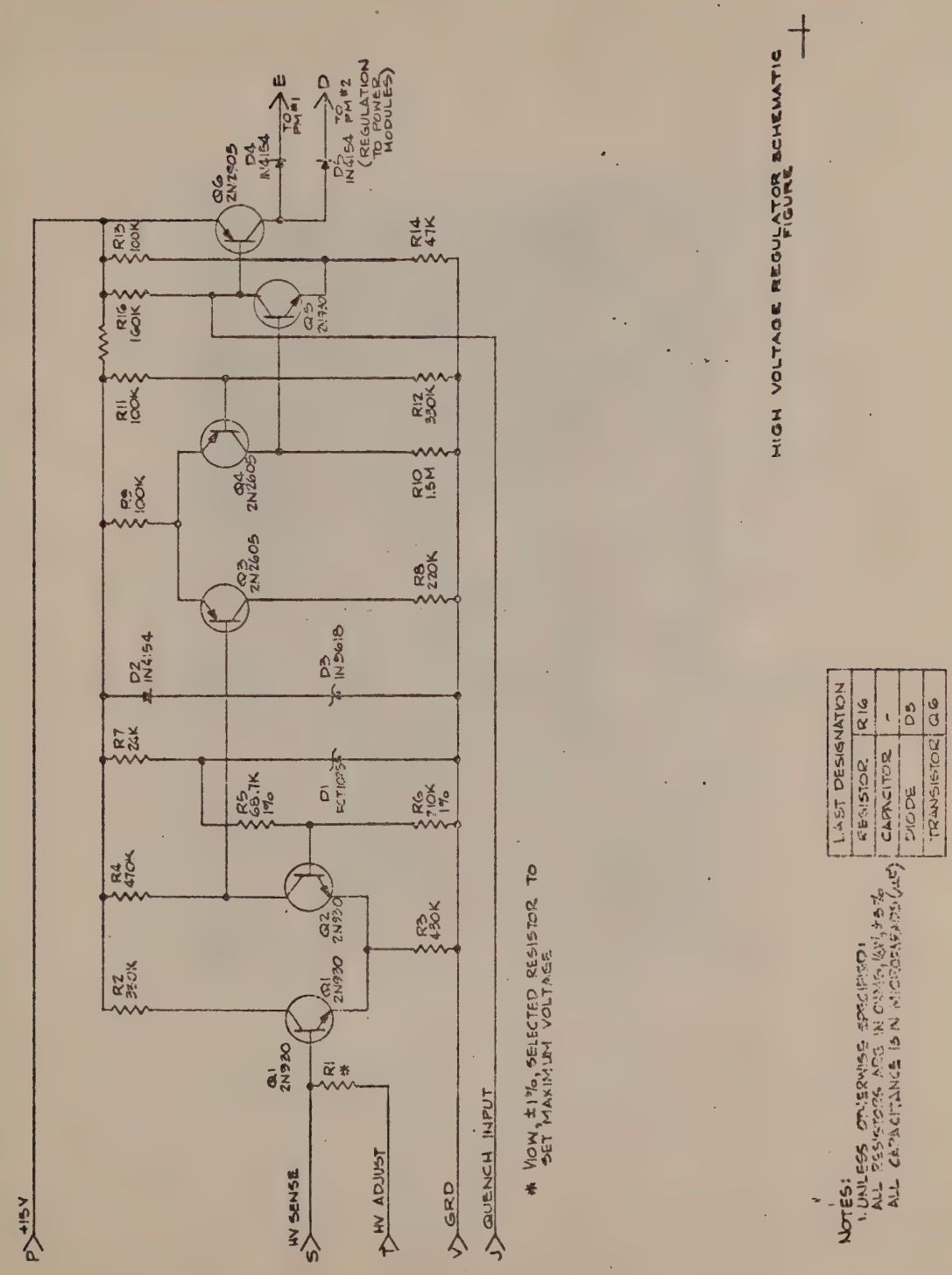


Figure E-16
High Voltage Regulator Schematic Diagram

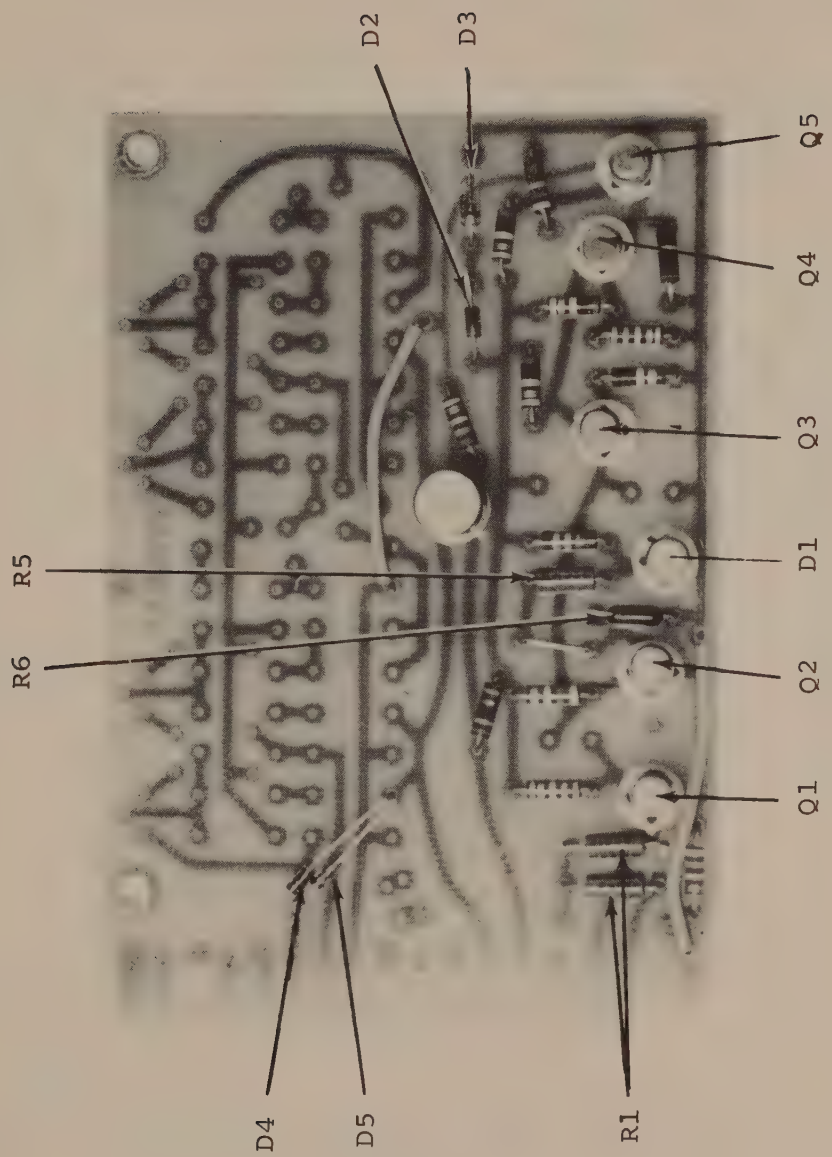


Figure E-17, High Voltage Regulator Assembly

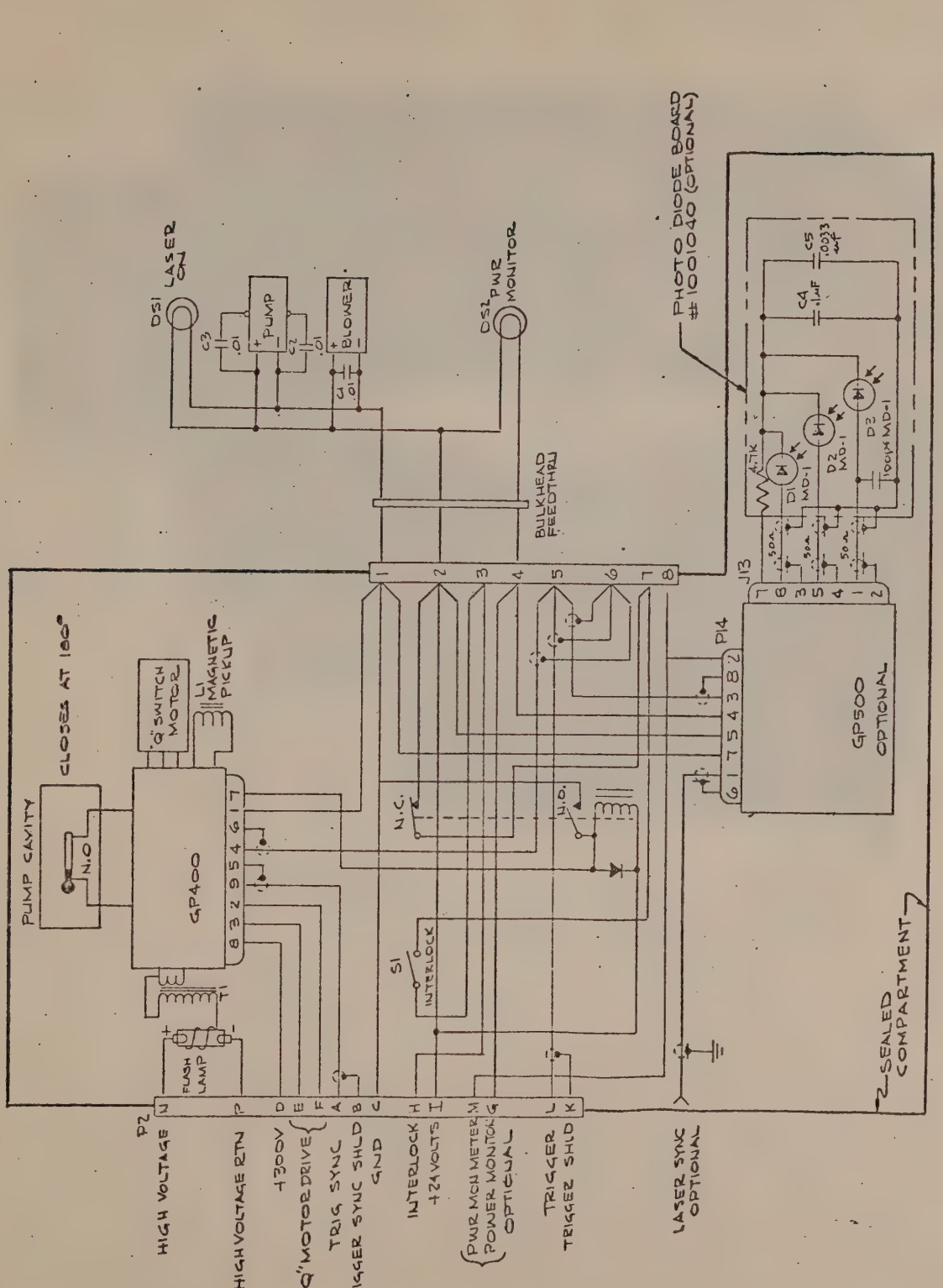


Figure E-18. Transmitter Schematic Diagram

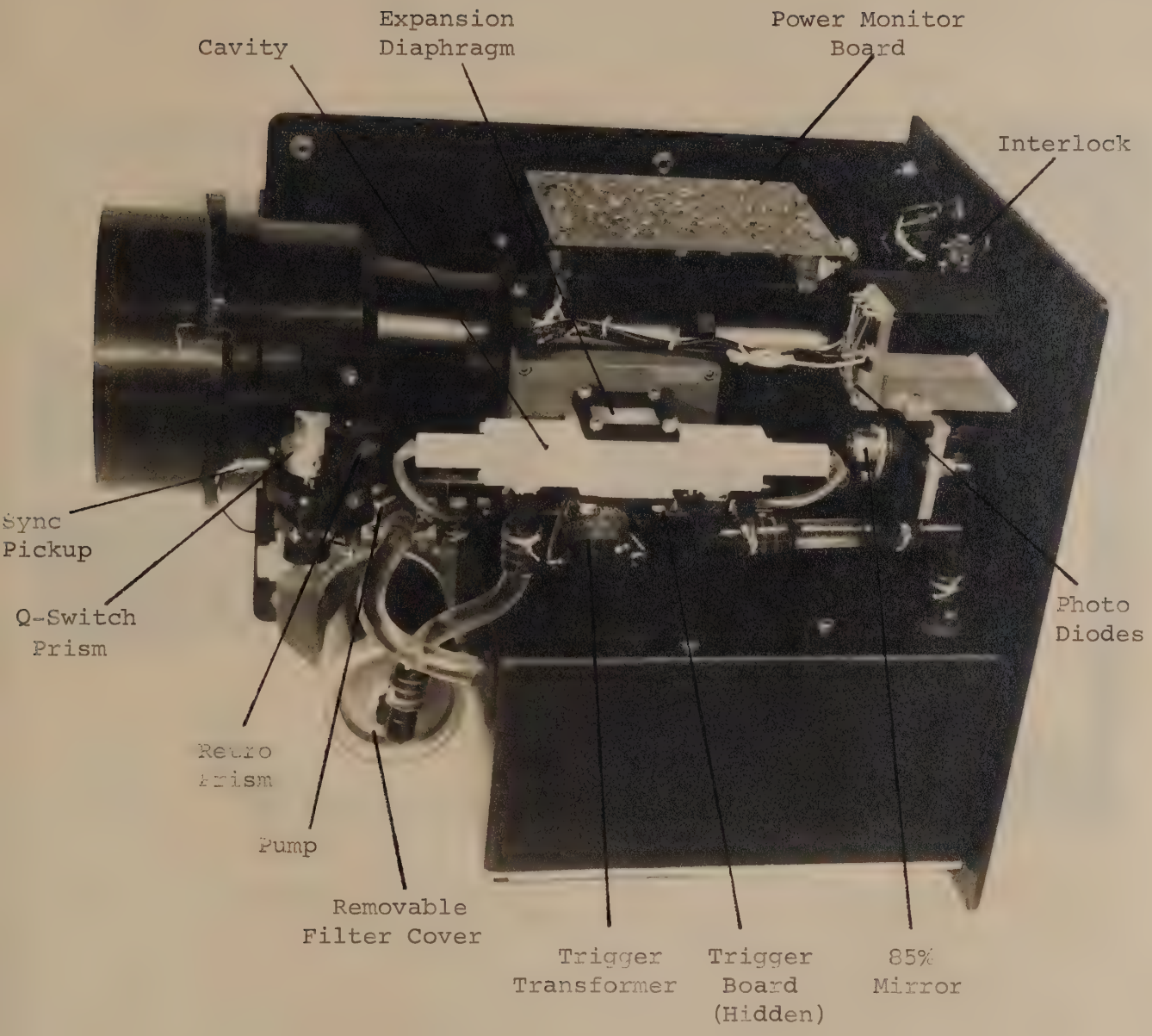


Figure E-19 Transmitter Right Side

PHOTOGRAPH COURTESY
INTERNATIONAL LASER SYSTEMS, INC.
3404 N. ORANGE BLOSSOM TRAIL
ORLANDO, FLORIDA 32804
(305) 295-4010

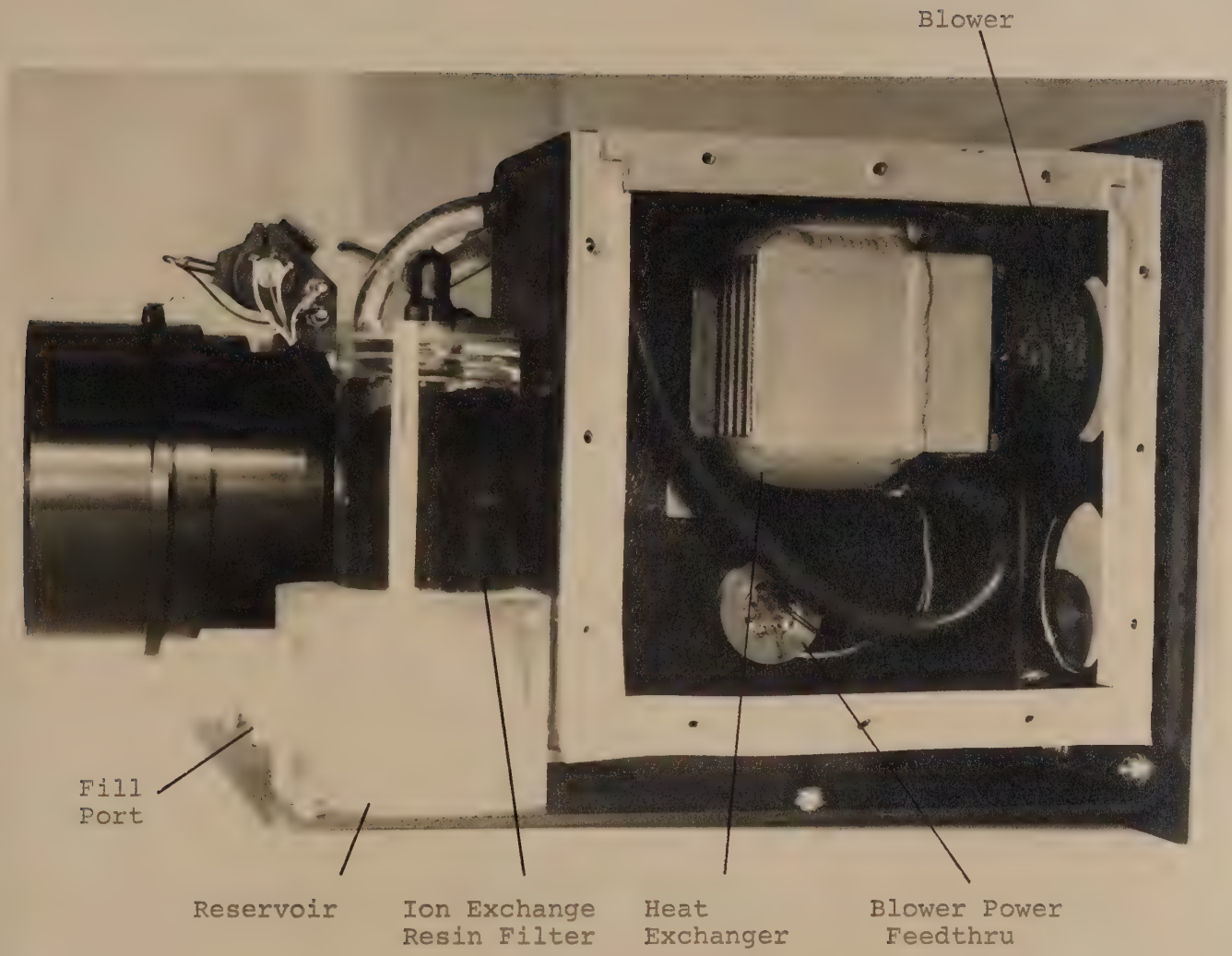


Figure E-20. Transmitter Left Side

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INTERNATIONAL LASER SYSTEMS, INC.
3404 N. ORANGE BLOSSOM TRAIL
ORLANDO, FLORIDA 32804
(305) 295-4010

Figure E-21 Deleted

Figure E-22 Deleted

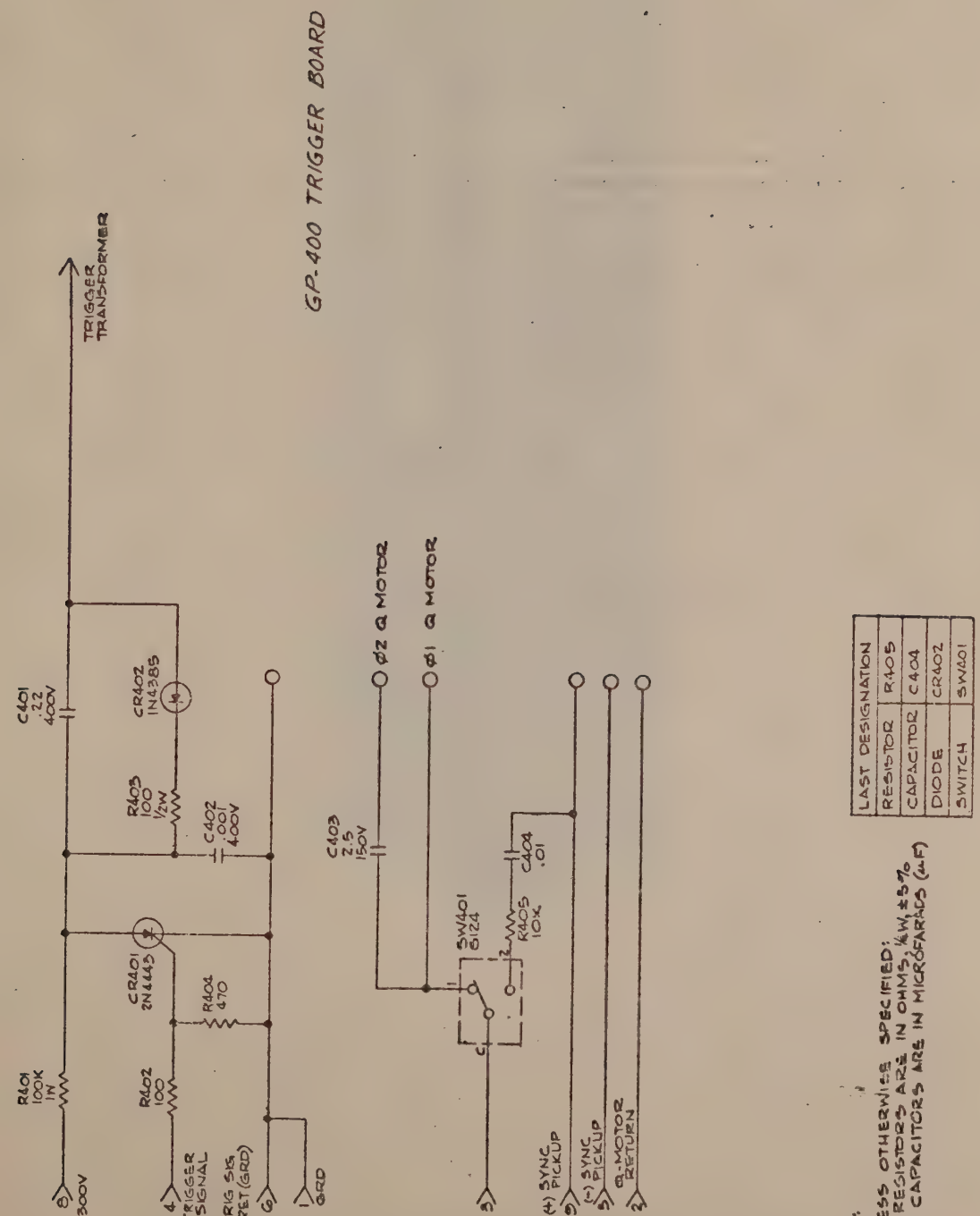


Figure E-23
GP-400 Trigger Generator Schematic Diagram

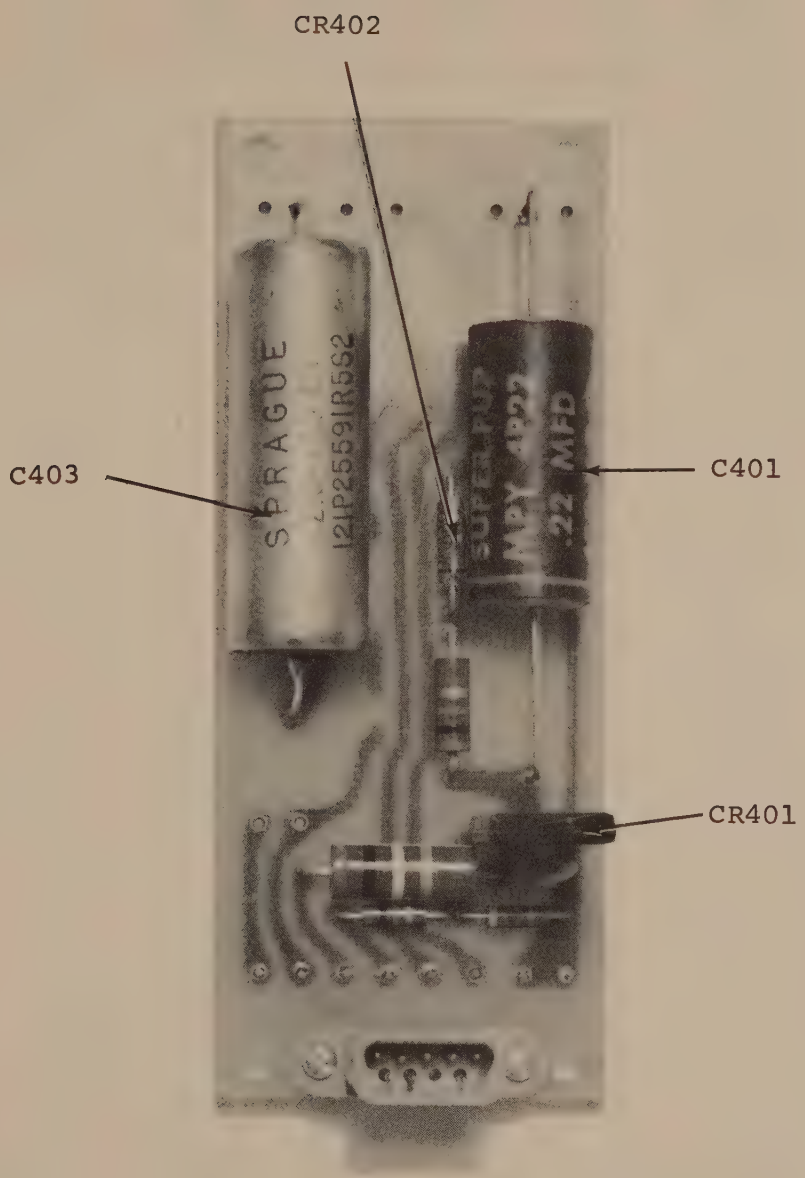
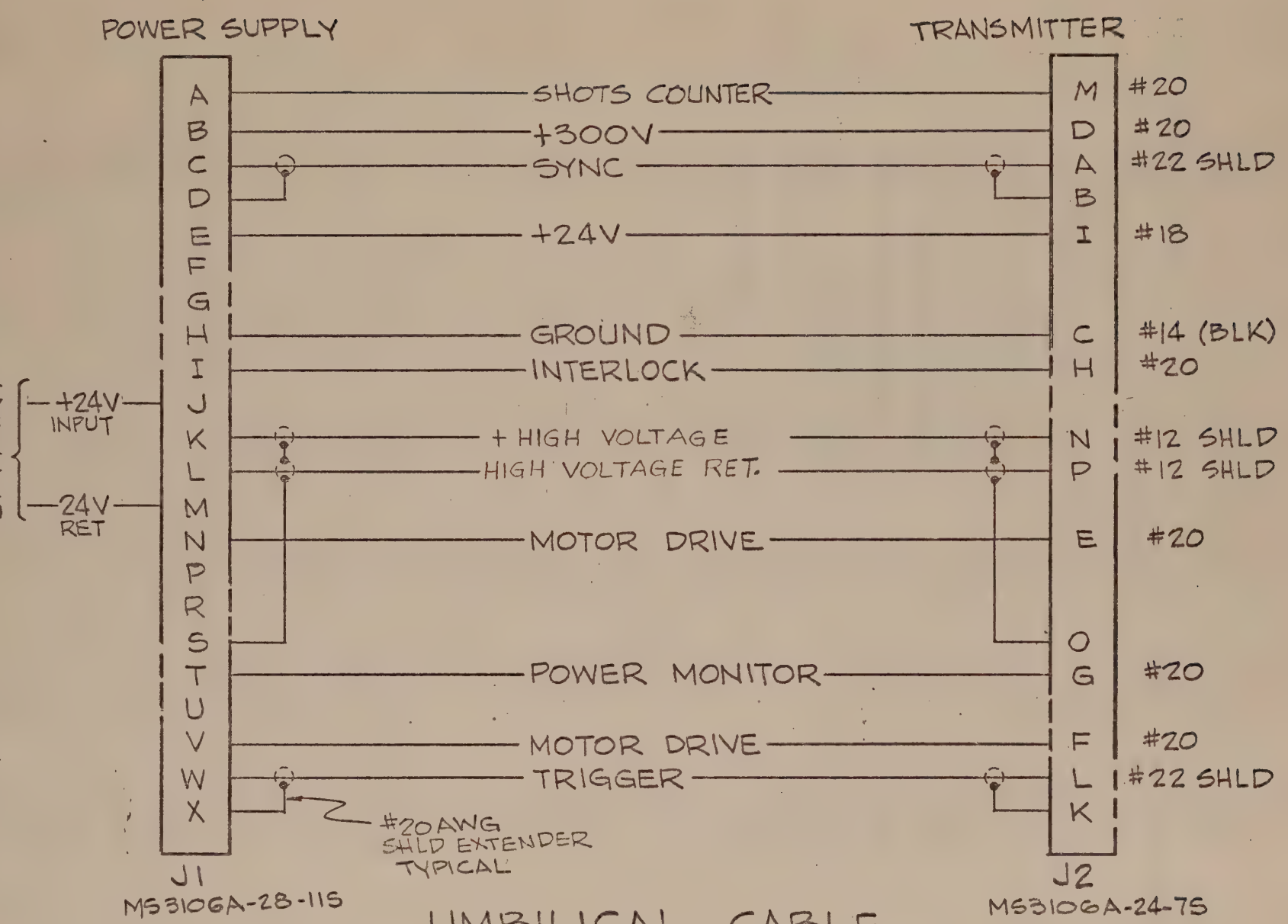


Figure E-24, GP-400 Trigger Generator Assembly



UMBILICAL CABLE DIAGRAM

Figure E-25 Umbilical Cable Schematic Diagram

F. PARTS LISTS

	Page No.
1. Power Supply	F-2
2. GP-100 Motor Driver	F-3
3. GP-200 Synchronizer	F-4
4. Low Voltage Regulator and Driver	F-5
5. Power Conversion Module	F-6
6. High Voltage Assembly	F-7
7. High Voltage Regulator	F-8
8. Transmitter	F-9
9. Trigger Board	F-12

PARTS LIST

Unit: Power Supply
Part No: 1001754-9
Mfg: International Laser Systems, Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	C-1	Capacitor 5800 uf, 50V	Sprague	7117L
1	C-2	Capacitor 30 uf, 2KV	Sprague	P195005
1	CB-1	Ckt Breaker, 20 Amp	Klixon	6MC1-5-20
1	CR-1	Diode, Zener		1N3326B
1	CR-2	Diode, Rectifier		1N4001
1	CR-3	Diode, Signal		1N1186AR
1	CR-4	Diode, Signal	Syl	1N4385
2	DS1,2	Lamp, Incandescent	GE	327
1	GP-100	Printed C.B.	ILS	GP100
1	GP-200	Printed C.B.	ILS	GP200
1	GP-300	Printed C.B.	ILS	GP300
1	J1	Connector, Cable	Amphenol	MS-3102A-28-11P
1	-	Knob	Raytheon	407-D1-K1
1	J2	Binding Post, Black	Superior	DF21-B
1	J3	Binding Post, Red		DF21-R
3	J7,10,11	Connector, P.C. Bd.	Amphenol	143-010-01
5	J4,5,6, 8,9	Connector, P.C. Bd.	"	143-018-01
1	K1	Relay, Power	Magnacraft	W88DX-3
1	L2	Inductor 33 uH	ILS	
1	M1	Meter 0-1ma	Simpson	1212
1	S1	Switch, Rotary	Alco	MRA-2-5S
2	S2,3	Switch,Toggle	C&K	7101
1	S4	Switch,Push Button	Grayhill	46-102-B
1	S5	Switch,interlock	UND LAB Inc.	A151-116-3-11
1	S6	Switch, Toggle	C&K	7201
1	R1	Pot. Trim,50K	Bourns	2361-1-503M
1	12G0007	Low VReg-Driver	Wilmore	12G0007
1	12G0009	Hi VReg.	"	12G0009
1	12G0010	HiVAssy	"	12G0010
2	12G0013	Pwr. Conv Mod	"	12G0013
1		Counter,Electro Magnetic	Presin	FR104/5g-119

PARTS LIST

Unit: Motor Driver
Part No: GP-100
Mfg: International Laser Systems, Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	A101	Dual F/F	MOT	MC856
1	A102	Quad Gate	MOT	MC846
1	CR103	Diode, Zener		IN5232
2	CR101, 102	Diode, Rect.		IN4385
1	C101	Cap., 68 μf, 35V	Kemet	6R8UF35V
1	C102	Cap, 33 μf, 10V	"	33UF10V
4	C103,104 105,108	Cap, .01 μf, 50V	"	
1	G101	Oscillator	Fork Stds	FO-7011S9
3	Q101, 106,107	Tran.Pwr,NPN	MOT	2N5191
2	Q102,103	Tran.Pwr,PNP	MOT	2N5194
6	Q104,105 108,109, 111,112	Tran.Sig,NPN	MOT	2N697
1	R101	Res,2W,1K	Ohmite	RC42GF102J
3	R102,111, 112	Res,2W,270	"	RC42GF271J
2	R103,109	Res,¼W,560	"	RC07GF561J
2	R104,108	Res,¼W,6.8K	"	RC07GF682J
2	R105,107	Res,¼W,330	"	RC07GF331J
2	R106,114	Res,½W, 1	"	RC20GF010J
1	R110,	Res,¼W,10K	"	RC07GF103J
1	R117	Res,¼W,5.6K	"	RC07GF562J
1	R115	Res,¼W,2.7K	"	RC07GF272J
2	R116, 120	Res,¼W,270	"	RC07GF271J
1	R121	Thermistor, 3K	Fenwal	KA33J1

PARTS LIST

Unit: Synchronizer
Part No: GP200/10
Mfg: International Laser Systems, Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	A203	Quad Gate	MOT	MC856P
2	A201,A202	Dual F/F	MOT	MC856P
2	A205	Decade Divider	Signetics	N8280A
1	A206	Hex Inverter	MOT	MC853P
1	C201	Capacitor, .01 MFD, 50V		
11	C202,204, 205,207, 208,209, 211,213, 214,215, 216	Capacitor, .01 μf ,50V		
2	C203,212	Capacitor, 1 μf ,35V	Kemet	R1UF35V
1	C210	Capacitor, .15 μf ,35V	"	R15UF35V
1	C206	Capacitor, 33 μf , 10V	"	R33UF10V
2	CR201,202	Diode,Signal	GE	IN4153
1	CR203	Diode, Zener		IN5232B
1	Q201	Tran,Sig.PNP	MOT	2N1132
1	Q202	Tran,Sig.NPN	MOT	2N697
1	Q203	Tran,Pwr.NPN	MOT	2N5191
1	R201	Res,¼W,180	Ohmite	RC07GF181J
3	R205,206 208	Res,¼W,10K	"	RC07GF103J
1	R215	Res,¼W, 6.8K	"	RC07GF682J
1	R207	Res,¼W, 4.7K	"	RC07GF472J
3	R202,203 214	Res,¼W, 2.7K	"	RC07GF272J
2	R212,216	Res,¼W 820	"	RC07GF821J
1	R209	Res,¼W, 1.2K	"	RC07GF122J
1	R213	Res,¼W, 180	"	RC07GF181J
1	R211	Res,2W,150	"	RC42GF151J
1	R210	Res,2W,1K	"	RC42GF102J
1	R204	Res,¼W,470	"	RC07GF471J

PARTS LIST

Unit: Low Voltage Regulator and Driver
Part No: 12G0007
Mfg: Wilmore Electronics Co., Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	C1	Capacitor, 15 μf, 20V	Sprague	150D156X0020B2
1	C2	Capacitor, .01 μf, 200V	Erie	CK06CW103K
1	C3	Capacitor, .056 μf, 100V	Erie	CK06CW563K
3	D1,10, 11	Diode, Signal	GE	IN4154
2	D2,3	Diode, Stabistor	GE	IN4156
1	D4	Diode, Zener	MOT	IN966B
1	D6-9	Diode Assy	Unitrode	673-5
6	Q1,2,5 8,9,10	Tran, Sig. NPN	MOT	2N2222
1	Q3	Tran, Sig, PNP	MOT	2N2905
1	Q4	Tran, Pwr, NPN	RCA	2N3054
2	Q6,7	Tran, Pwr, NPN	MOT	2N2405
1	R1	Res, ¼W, 43K	Ohmite	RC07GF433J
2	R2,4	Res, ¼W, 510K	"	RC07GF514J
2	R3,14	Res, ¼W, 47K	"	RC07GF473J
1	R5	Res, ½W, 6.2K	"	RC20GF622J
1	R6	Res, ¼W, 200	"	RC07GF201J
2	R7,19	Res, ¼W, 30	"	RC07GF300J
2	R8,11	Res, ¼W, 4.3K	"	RC07GF432J
1	R9	Res, 2W, 15K	"	RC42GF153J
1	R10	Res, 1W, 1Meg.	"	RC32GF105J
1	R12	Res, ¼W, 82K	"	RC07GF823J
1	R13	Res, ¼W, 220K	"	RC07GF224J
1	R15	Res, ¼W, 6.8K	"	RC07GF682J
1	R16	Res, ¼W, 51K	"	RC07GF513J
1	R17	Res, ¼W, 1.8K	"	RC07GF182J
1	R18	Res, ½W, 3.9K	"	RC07GF392J
1	T1	Transformer	Wilmore	31A0069

PARTS LIST

Unit: Power Conversion Module
Part No: 12G0013
Mfg: Wilmore Electronics, Co., Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	C1	Capacitor, .01 μf,	Erie	
1	C2	Capacitor, .001 μf	Sprague	192P10292
1	C3	Capacitor, .0047 MFD	Erie	
4	D1,4,5,9	Diode, Rect.	MOT	IN4934
1	D2	Diode,Signal	GE	IN4154
1	D3	Diode,Rect.	Westinghouse	IN3880
1	D6	Diode,Rect.	"	IN1342A
1	D7	Diode,Rect.	Unitrode	UT4010
1	D8	Diode, H.V.Rect.	"	86-345
1	D10	Diode,Zener	TRW	LVA-8.2A
1	Q1	Transis,SCR	MOT	2N2324
2	Q2,Q4	Transis,Pwr	MOT	2N5686
1	Q5	Transis,Sig. NPN	MOT	2N2222
1	R1	Resistor,2W, 75	Ohmite	RC42GF750J
1	R2	Resistor,½W,2K	"	RC20GF202J
1	R3	Resistor,½W,1Ω	"	RC20GF010J
1	R4	Resistor,½W, 75Ω	"	RC07GF101J
1	R5	Res,½W, 1K		RN65C
1	R6	Res,½W,10K	"	RC20GF103J
2	R7,8	Res,½W,33Ω	"	RC20GF330J
1	R9	Res,½W,56Ω	"	RC20GF560J
1	R10	Res,½W,4.7K	"	RC20GF472J
1	T1	Trans, Power	Wilmore	31A0053
1	T2	Transformer	Wilmore	31A0035
1	T3	Transformer	Wilmore	31A0027A

PARTS LIST

Unit: High Voltage Assembly
Part No: 12G0010
Mfg: Wilmore Electronics Co., Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	C1	Capacitor, .1 μf, 2000V	Dearborn	AM66A1J104K
4	D1,2,3,4	Diode	Unitrode	UT236
1	K1	Relay, Hi Volt.	Jenning, ITT	RF-1D
3	R1,9,10	Res,1w,24	Ohmite	RC32GF240J
1	R2	Res,2%, 15meg	Caddock	MG721
1	R3	Res,¼W,10	Ohmite	RC07GF100J
4	R4,5,6,7	Res,1W,1.5K	Ohmite	RC32GF152J
1	R8	Res,¼W,10K	Ohmite	RC07GF103J

PARTS LIST

Unit: High Voltage Regulator
Part No: 12G0009
Mfg: Wilmore Electronics Co., Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	C1	Cap, .001 μfd	Any	
1	D1	Diode,Zener	Fairchild	FCT1025
3	D2,4,5	Diode,Signal	GE	IN4154
1	D3	Diode,Zener	MOT	IN961B
3	Q1,2,5	Trans.Sign,NPN	Solitron	2N930
2	Q3,4	Trans,Sig,PNP	"	2N2605
1	Q5	Trans,Sig,PNP	MOT	2N2905
1	R1	Res,1/10W,1% Select	Sprague	RN55C-
2	R2,12	Res,¼W,330K	Ohmite	RC07GF334J
1	R3	Res,¼W,430K	"	RC07GF434J
1	R4	Res,¼W,470K	"	RC07GF474J
1	R5	Res,1/10W,1%	Sprague	RN55C6872F
1	R6	Res,1/10W,1% 210K	Sprague	RN55C2103F
1	R7	Res,¼W,24K	Ohmite	RC07GF243J
1	R8	Res,¼W,220K	"	RC07GF224J
3	R9,11,13	Res,¼W,100K	"	RC07GF104J
1	R10	Res,¼W, 1.5Meg	"	RC07GF155J
1	R14	Res,¼W, 47K	"	RC07GF473J
1	R15	Res,¼W, 1.3K	"	RC07GF132J
1	R16	Res,¼W,160K	"	RC07GF164J

PARTS LIST

Unit: Transmitter
Part No: 1004645 (NC-10/80)
Mfr: International Laser Systems, Inc.

Quantity	Code	Description	Mfr	Part No.
3	C1,2,3	Cap., .01 MFD, 50V		
1	C4	Cap., .1 MFD, 50V		
1	C5	Cap., .0033 MFD, 50V		
1		Cap., 100 PF, 50V		
3	D1,2,3	Diode, Photo	Monsanto	MD-1

Pages F-10 and F-11 Deleted

PARTS LIST

Unit: Trigger Board
Part No: GP-400
Mfg: International Laser Systems, Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	C401	Capacitor, .22 MFD ,400V	CDE	MPY4P22
1	C402	Capacitor, .001 MFD		
1	C403	Capacitor, 2.5 MFD ,150V	Sprague	121P25591R5S2
1	C404	Capacitor, .01 MFD		
1	CR401	Diode,Rectifier	Syl	IN385
1	Q401	Tran, SCR	MOT	2N4443
1	R401	Res,1W,100K	Ohmite	RC32GF104J
1	R402	Res,¼W,100	"	RC07GF101J
1	R403	Res,½W,100	"	RC20GF101J
1	R404	Res,¼W,470	"	RC07GF471J
1	R405	Res, 1/4W, 10K	"	RC07GF103J

APPENDIX I

AC TO DC LINE CONVERTER

Description

The AC to DC to DC Line Converter accessory (Figure I-1) to the laser system has been designed to provide an economical means of powering the system from a 115V, 60 cycle, single phase power source. The converter is housed in a matching cabinet to the power supply, and weighs approximately 25 lbs. The converter supplies 24 volt DC power with sufficient current capability to supply all the system demands.

Functional Analysis (Figures I-1, I-2)

115 volt, 60 cycle, single phase AC power is supplied to the primary winding of transformer T1 through the on-off switch S1 and fuse F1. Two 18 volt RMS AC secondaries are paralleled to obtain adequate current capability. By utilizing the 105 volt tap on the primary winding, the secondary AC voltage is increased to approximately 22 volts RMS (30V peak). This current is rectified by bridge rectifier diodes D1 through D4. Capacitors C1-C3 comprise a 75,000 μfd filter and energy storage bank that is charged to a higher DC voltage than the RMS value of the transformer secondaries.

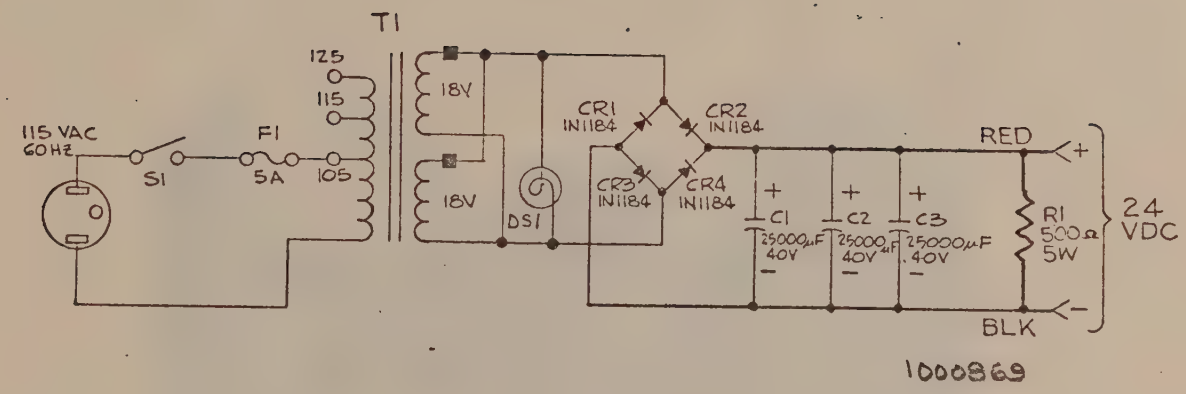


Figure I-1. AC Line Converter, Schematic Diagram

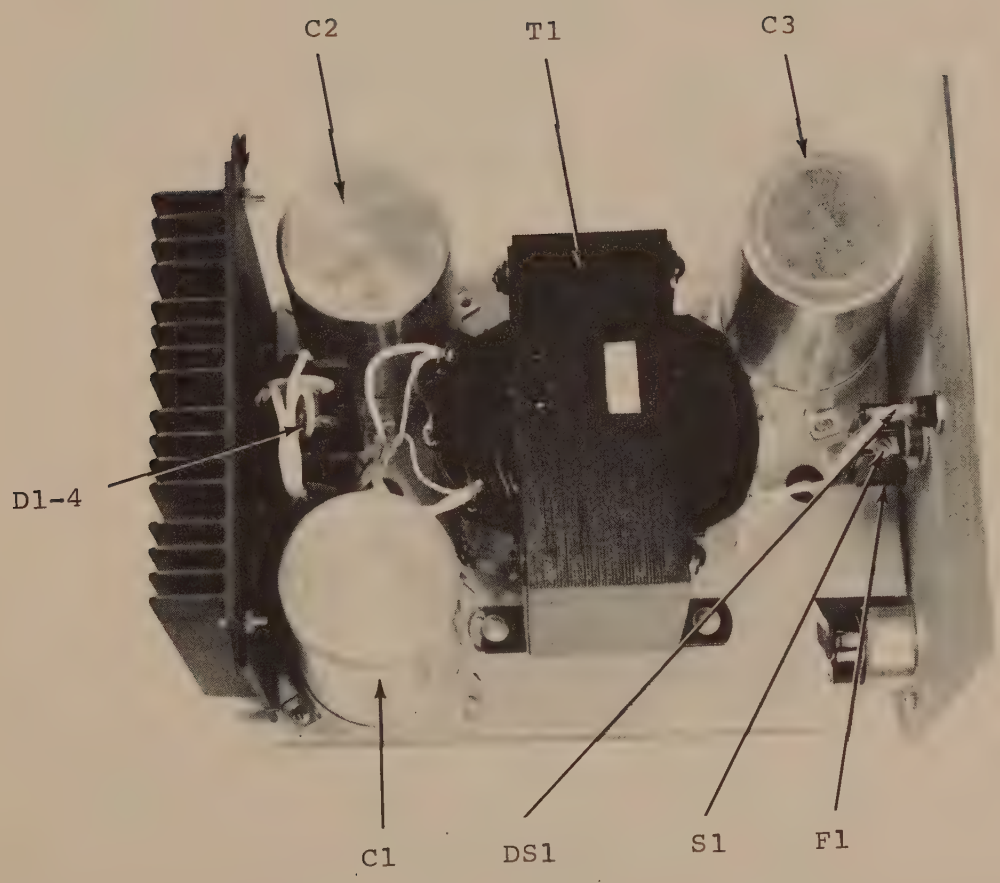


Figure I-2, Converter Assembly

PARTS LIST

Unit: AC Line Converter
Part No:
Mfg: International Laser Systems, Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
3	C1,2,3	Cap,Electrolytic 25,000 MFD ,40V	Sprague	36D
4	CR1,2,3,4	Diode, Power	MOT	IN1184
1	DS1	Lamp,Indicator	GE	327
1	F1	Fuse, 5 Amp S10-blo	Little-fuse	313-3AG
1	S1	Switch,DPST	Cutler Hammer	16 Amp-125V
1	T1	Transformer, Power	Lec-tronic	35-12
1	R1	Resistor, 500Ω, 5W		

APPENDIX II

THRESHOLD POWER MONITOR

Description

The threshold power monitor accessory to the laser system provides a visual indication of the laser output power on a pulse-to-pulse basis. It is not an analog or absolute value monitor, but may be adjusted to operate at any desired power level. When set to a specific value, the power indicator lamp will be illuminated for approximately half the interpulse period following each laser pulse of a power equal to or greater than the set value.

The information derived from this type of monitoring is:

a. Lamp on for every pulse - laser output somewhere above preset level

b. Lamp blinking for approximately half the pulses - laser output averaging about the preset level

c. Lamp never on - laser output well below preset level, or no output

The sensitivity of this power monitor is greater than the pulse-to-pulse amplitude stability of the laser. Therefore, a reasonable estimate of laser performance may be interpreted from observing the ratio of on-to-off pulses.

Functional Analysis (Figures E-18 and II-1)

The threshold power monitor receives its input from a photodiode (D2 in Figure E-18), that receives a sample of the laser energy. The small fraction of laser energy reflected from the beamsplitter causes the diode to conduct, and produces a positive pulse at pin 5 of J 13 on the GP-500 printed circuit board. Bias for the photodiode is obtained from the +24V power line in the GP-500 board, and appears at J13 pin 7 of the assembly.

This positive pulse is directly proportional in amplitude to the laser output energy. It is applied to a load resistor R512 at P13, pin 5 of the GP-500 board, and to the input pin 6 of the A501 integrated circuit. The MC1035 integrated circuit contains 3 separate differential amplifiers. The first is utilized as a high

APPENDIX II (CONTD)

gain differential level sensor, with the pulse input at pin 6, reference input at pin 5, and the output at pin 8. The second differential amplifier within the MC1035 IC is connected as a Schmidt trigger. The output of the first amplifier (pin 8) is applied to the ST at pin 10. The output of the ST at pin 12 is applied to the 3rd stage within the MC1035 IC which is connected as a monostable multivibrator. C506 is the timing and feedback capacitor for the monostable MV. The output from pin 1 is applied through amplifier Q503 to lamp driver Q505.

To prevent the noise generated by the flashlamp trigger from creating false power monitor signals, Q504 and Q502 inhibit the monostable MV. The inhibit signal is the SCR trigger signal used in the GP-400 trigger generator, and as such slightly preceeds the actual high voltage trigger pulse.

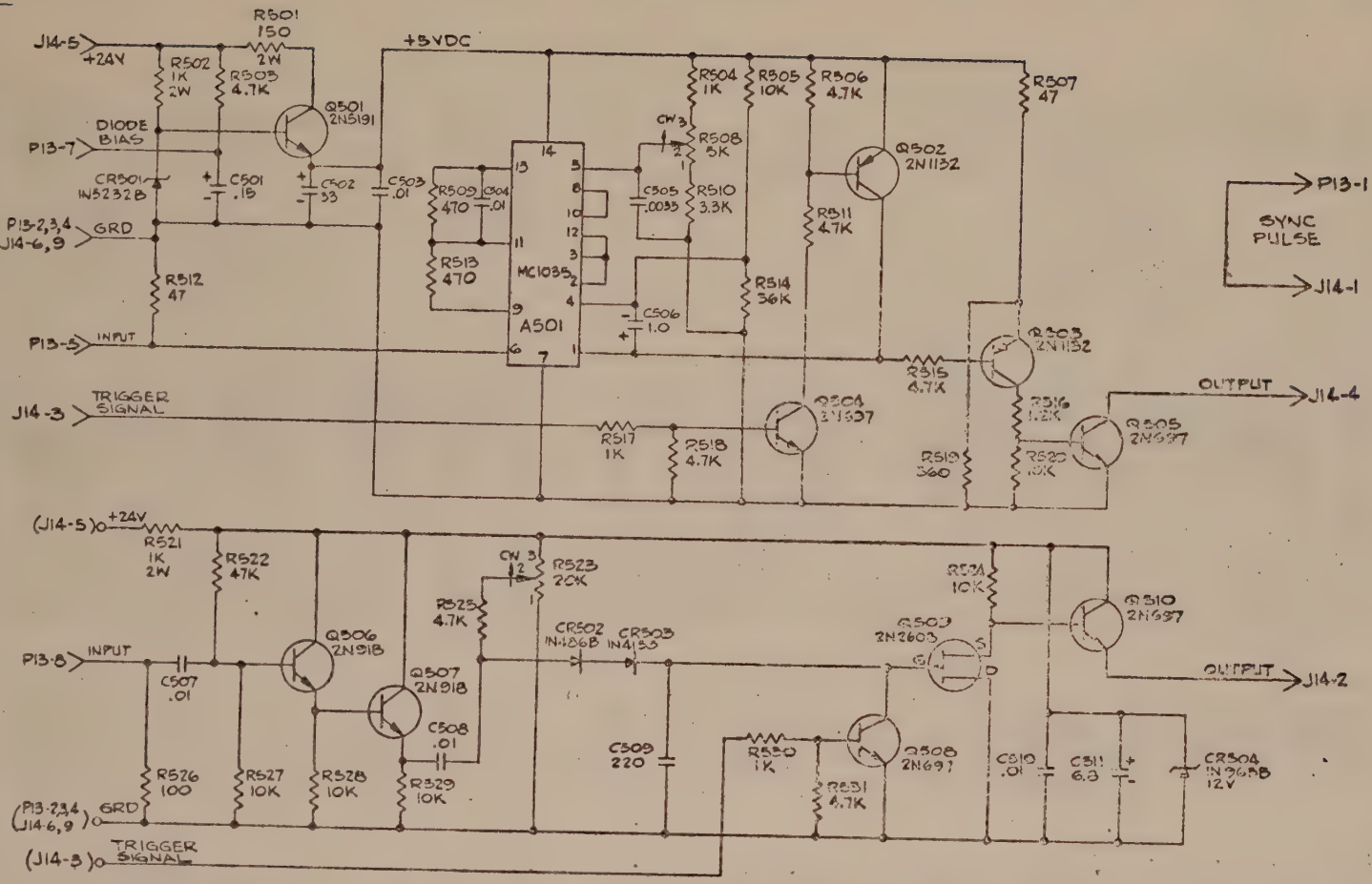


Figure II-1 GP-500 Power Monitor Schematic Diagram

II-3

POWER MONITOR SCHEMATIC FIGURE

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS, 1/4W, ±5% ALL CAPACITATORS ARE IN MICROFARADS

LAST DESIGNATION	
RESISTOR	R531
CAPACITOR	C511
DIODE	CR504
TRANSISTOR	Q510
INTEGRATED CKT	A501

QTY REQD	ITEM	PART NUMBER	SYM	DESCRIPTION	CODE IDENT NO	MATERIAL AND SPECIFICATIONS
← ASSY				LIST OF PARTS		

DASH NO	REQD	NEXT ASSY	USED ON
		APPLICATION	

TOLERANCE UNLESS SPECIFIED .xx — .xxx — FINISH ✓ ANGLES ±

MATERIAL —

FINISH —

SIGNATURES	DATES
DRAFTSMAN	
CHECKER	
APPD	
APPD	
I L S APPD	
CUTOMER APPD	

INTERNATIONAL LASER SYSTEMS INC.
ORLANDO, FLORIDA

TITLE SCHEMATIC DIAGRAM GP500 BOARD

SIZE	CODE IDENT NO	DRAWING NO	REV
C			

SCALE — SHEET OF

I L S Form No 116

PARTS LIST

Unit: Power Monitor Circuit Assembly
Part No: GP-500
Mfg: International Laser Systems, Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	A501	Integrated Circuit	MOT	MC1035
1	C501	Capacitor, .15 , 35	Kemet	6746MP
1	C502	Capacitor, 33 , 10V	Kemet	6936NR
5	C503,504, 507,508,510	Capacitor, .01	Centra-lab	
1	C505	Capacitor,0033	Any	
1	C506	Capacitor, 1.0 , 35	Kemet	6928TH
1	C509	Capacitor, 220	Any	
1	C511	Capacitor, 6.8 , 35V	Kemet	6918ME
1	CR501	Diode,Zener, 5.6V	Any	IN5232B
1	CR502	Diode,Signal	Any	IN486B
1	CR503	Diode,Signal	GE	IN4153
1	CR504	Diode,Zener,12V	Any	1N963B
1	Q501	Transistor,Power NPN	MOT	2N5191
2	Q502,503	Transistor,Signal, PNP	MOT	2N1132
4	Q504,505 508,510	Transistor,Signal NPN	MOT	2N697
2	Q506,507	Transistor,Signal NPN	MOT	2N918
1	Q509	Transistor,Field Effect	Silicon-IN	2N2608
1	R501	Res,2W,150	Ohmite	RC42GF151J
2	R502,521	Res,2W1K	"	RC42GF102J
6	R503,506,511 515,518,525,531	Res,¼W, 4.7K	"	RC07GF472J
3	R504,517,530	Res,¼W, 1K	"	RC07GF102J
6	R505,520,524 527,528,529	Res,¼W, 10K	"	RC07GF103J
2	R507,512	Res,¼W,47	"	RC07GF470J
1	R508	Res,Variable 5K	Bourns	3067P-1-502

PARTS LIST (CONTD)
Part No. GP-500

Quantity	Code	Description	Mfg.	Mfg. Part No.
2	R509,513	Res,¼W, 470	Ohmite	RC07GF471J
1	R510	Res,¼W, 3.3K	"	RC07GF332J
1	R514	Res,¼W, 56K	"	RC07GF563J
1	R516	Res,¼W, 1.2K	"	RC07GF122J
1	R519	Res,¼W, 560	"	RC07GF561J
1	R522	Res,¼W, 47K	"	RC07GF473J
1	R523	Res,Variable,20K	Bourns	3067P-1-203
1	R526	Res,¼W, 100	Ohmite	RC07GF101J

APPENDIX III

ANALOG POWER MONITOR

Description

The analog power monitor produces a meter readout of laser output power expressed as a percentage of full power. Each laser pulse is sampled and an analog pulse, whose peak amplitude is proportional to the laser peak power, is stored in a sample-and-hold circuit. This peak voltage is displayed on the analog power meter and is also available externally as a telemetry or recorder output. The meter and T/M output is linear and accurate between 50% and 100% of full scale on the meter. Meter linearity and response sensitivity decreases below 50% of full laser power, to the point where the meter will read approximately 25% of full scale when power is applied but the laser is not operating. The inability to accurately measure power below 50% of full power is not significant in the laser, since the laser pulse-to-pulse variations make the system unuseable at these levels.

Functional Analysis (Figure II-1)

A photodiode mounted on the interferometer bed receives laser energy reflected from the beamsplitter and produces a positive pulse whose amplitude is directly proportional to the peak power of the laser pulse. This pulse is applied to pin 8 of P13 on the GP-500 PC board.

The sample pulse is coupled through cascaded emitter follower stages Q506 and Q507 to obtain sufficient current to charge storage capacitor C509 to the peak voltage of the pulse. The charge current for C509 is passed through two seriesed diodes, CR502 and CR503. CR502 is a high inverse impedance diode, and CR503 is a low capacity, fast recovery diode. The seriesed pair increases the reverse leakage and decreases the series capacitance at the input to C509. The voltage thus stored on C509 is applied to high impedance FET Q509 which draws very little current from C509, thus maintaining the voltage on C509 almost constant.

When the trigger to the SCR in the GP-400 trigger generator occurs, signifying the end of one interpulse period and the beginning of the next, Q508 is turned on. Q508 discharges C509 in preparation for the next pulse. Between the time the laser pulse occurs, and next trigger is generated, Q509 supplies a voltage to the base of Q510 that is proportional to the voltage stored in C509. Q510 in turn supplies current to the meter and T/M circuit in the transmitter. R523 adjusts the positive bias applied to CR502 and CR503, C509, and Q509. This bias is required to compensate for the forward voltage drop across the series diodes and to operate the FET in the linear portion of its range.

Resistor R3 in the transmitter (see Figure E-18) adjusts the meter reading to full scale at maximum laser power. Resistor R1 is adjusted to produce the voltage desired at the T/M output.

APPENDIX IV

REMOTE CONTROL AND MONITORING

Description

The remote control and monitoring accessory to the laser system consists of two hardware units that provide the capability of energizing and de-energizing the laser and monitoring the laser operations. This option is dependent upon the threshold power monitor accessory described in Appendix II.

The Remote Control/Monitor box (Figure 1) provides a switch for laser on-off control, a meter for indicating whether the laser is on or off, and a miniature loudspeaker that produces a 50 millisecond tone (beep) each time the laser emits a pulse whose power exceeds the level set by the threshold power monitor. The GP-300 printed circuit board accepts an audio tone signal from the motor driver circuit and gates this signal to the remote lines each time the threshold power monitor is triggered.

Functional Analysis (see Figure IV-1)

An audio tone signal is taken from the motor driver circuit, and gated to the remote control lines by the threshold detecting power monitor. The audio signal is continuously applied to the base of transistor Q302 through R304. This signal is gated by the power monitor gate through R306 and Q301. Q301 is normally conducting, effectively grounding the base of Q302. A laser pulse above the preset threshold will cause the power monitor input to go near ground for approximately half the interpulse period. Q302 will then amplify the tone signal which, after further amplification by Q303, is applied to the remote control lines.

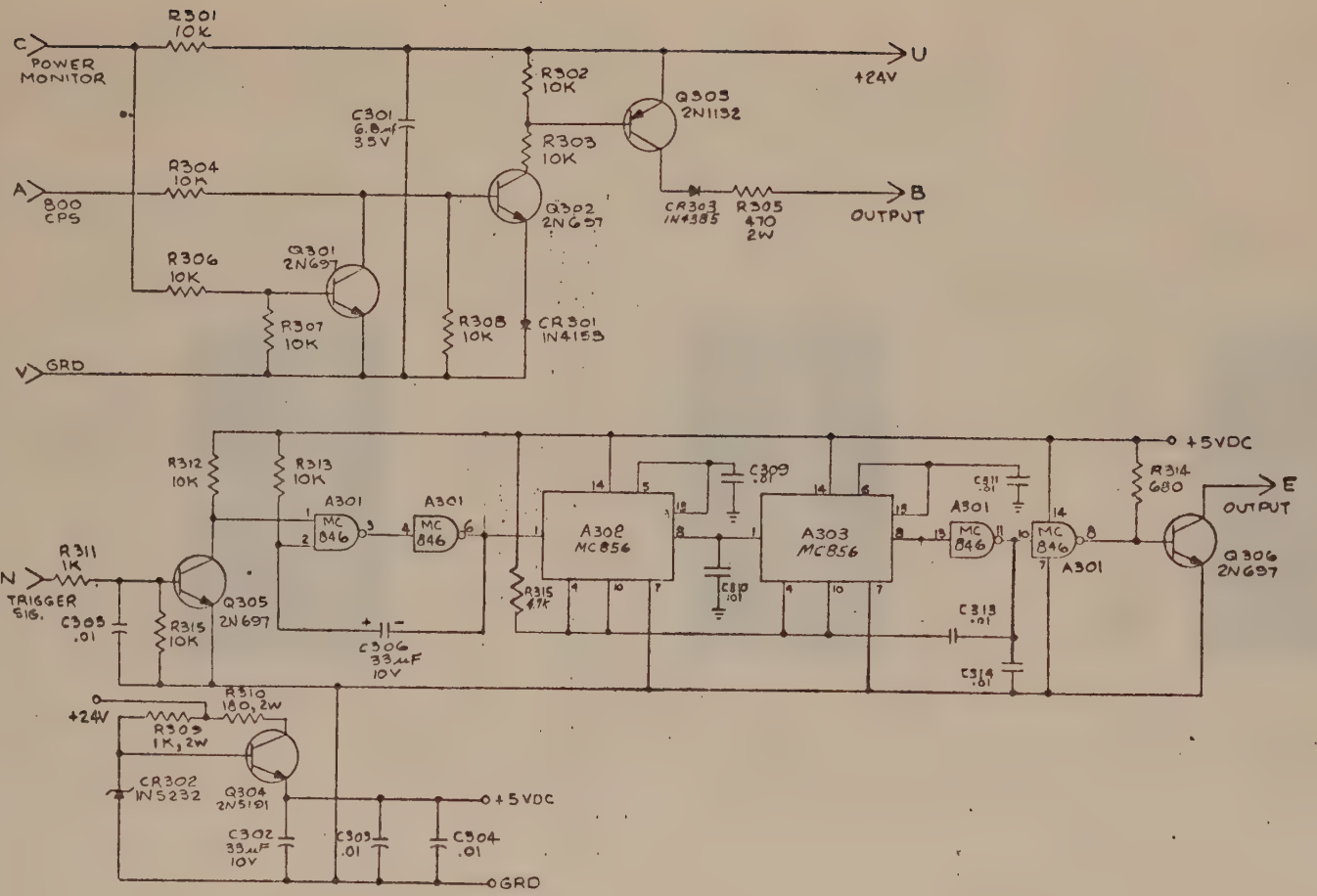


Figure IV-1
GP-300 Schematic Diagram

QTY REQD	ITEM	PART NUMBER	SYM	DESCRIPTION	CODE IDENT NO	MATERIAL AND SPECIFICATIONS
	ASSY			LIST OF PARTS		

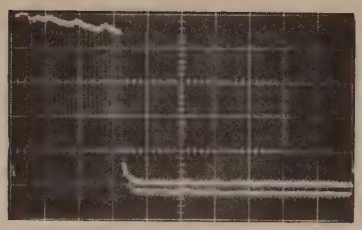
TOLERANCE UNLESS SPECIFIED .xx .xxx FINISH ANGLES
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION
DASH NO | REQD

SIGNATURES | DATES
DRAFTSMAN
CHECKER
APPD
APPD
I L B APPD
CUSTOMER APPD

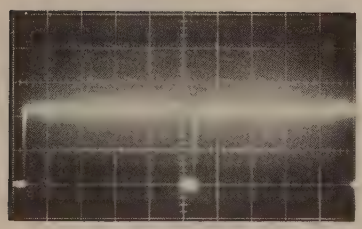
INTERNATIONAL LASER SYSTEMS INC.
ORLANDO, FLORIDA

TITLE GP-300
REMOTE POWER MONITOR
SHOTS COUNTER

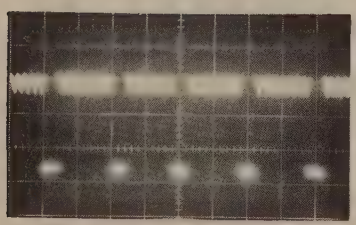
SIZE C | CODE IDENT NO | DRAWING NO 1000412 | REV
SCALE | SHEET OF



5 V/cm, 10 ms/cm
Remote P/M output



2 V/cm, 20 ms/cm
A301, pin 6
Shots counter input



10 V/cm, .5 Sec/cm
Q306 collector
Shots counter output

Figure IV-2, GP300 Remote P/M, Shots Counter Waveforms

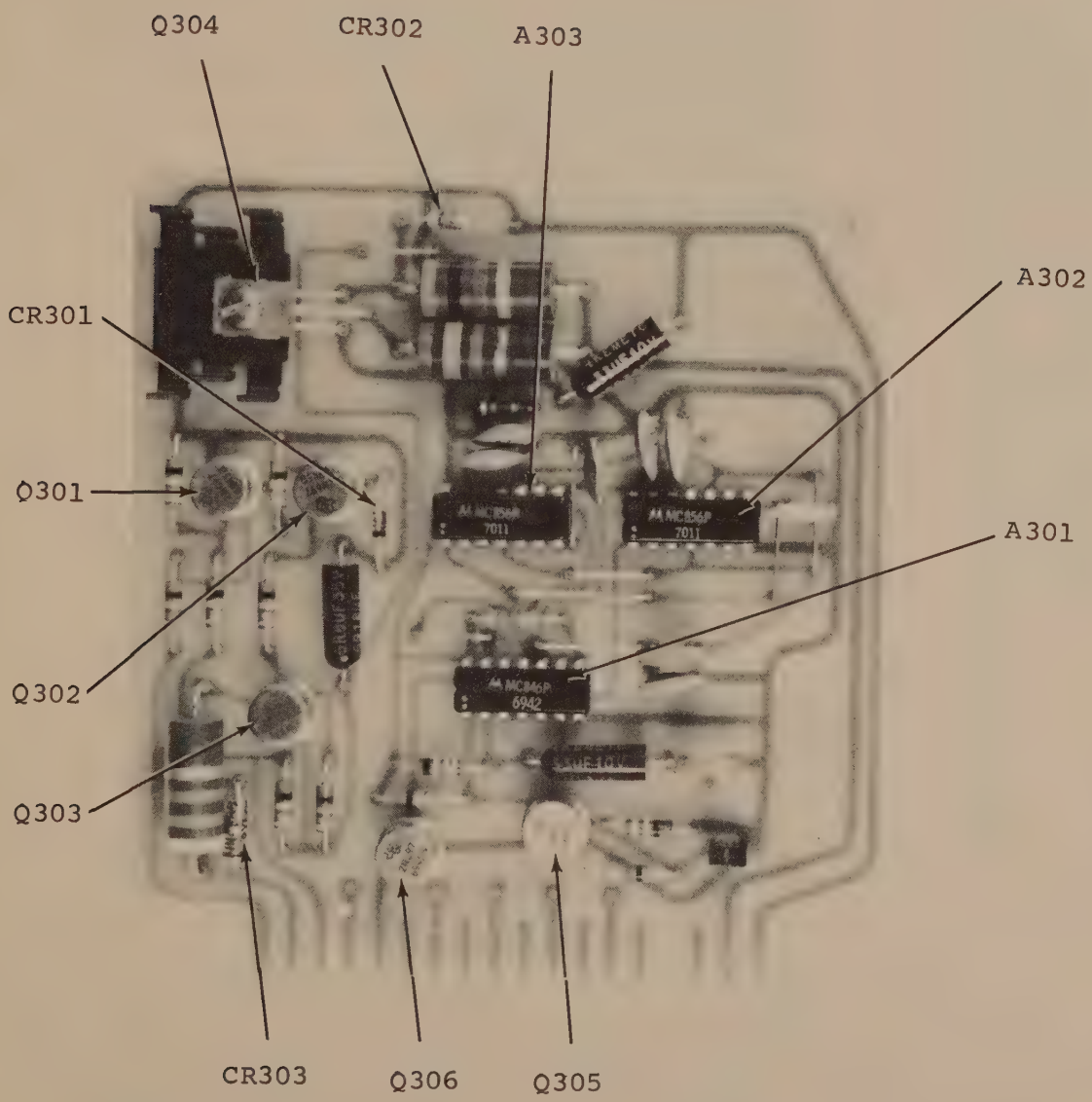


Figure IV-3, GP300, Remote Control/Shots Counter

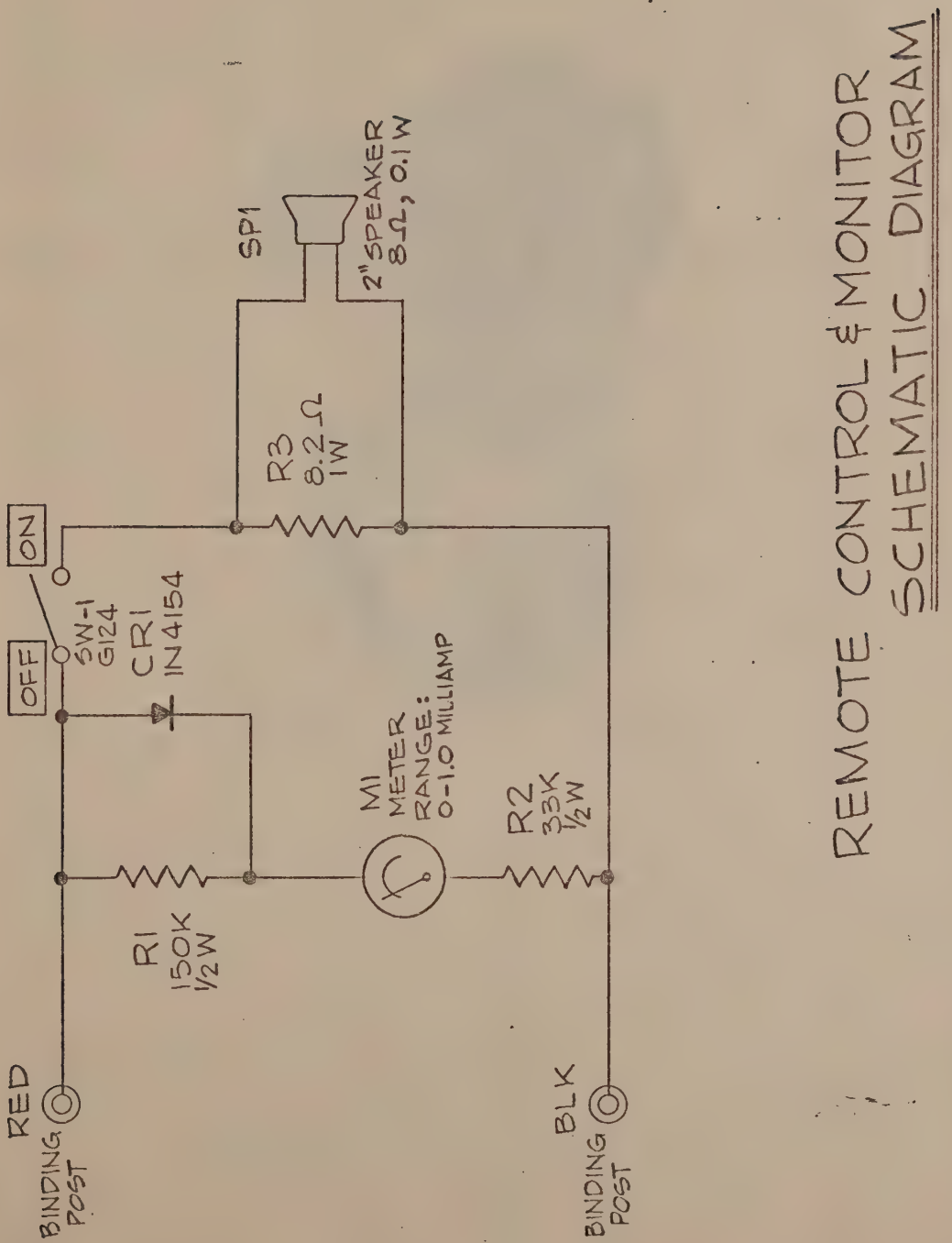


Figure IV-4.
Remote Control/Monitor Schematic Diagram

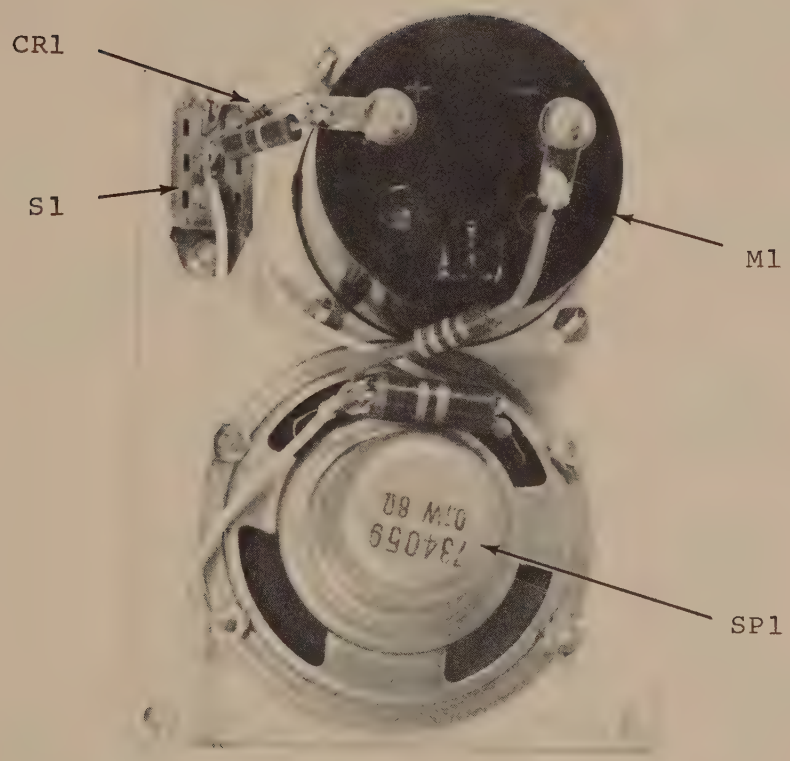


Figure IV-5, Remote Box Assembly

PARTS LIST

Unit: Remote Power Monitor & Shots Counter Board
Part No: GP-300
Mfg: International Laser Systems, Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	A301	Quad Gate	MOT	MC846P
1	A302	Decade Counter	Signetics	N8280A
1	A303	Dual Flip-Flop	MOT	MC856P
1	C301	Capacitor, 68 MFD, 35V	Kemet	6R8UF35V
2	C302,306	Capacitor, 33 MFD ,10V	"	33UF10V
9	C303,304, 305, 309, 310,311, 312,313,314	Capacitor, .01 MFD ,50V	"	
1	CR301	Diode,Signal	GE	IN4153
1	CR302	Diode,Zener 5.6V		IN5232
4	Q301,302, 305,306	Tran,Sig,NPN	MOT	2N697
1	Q303	Tran,Sig,PNP	MOT	2N1132
1	Q304	Tran,Pwr,NPN	MOT	2N5191
10	R301,302, 303,304,306,307, 308,312,313,315	Res,¼W, 10K	Ohmite	RC07GF103J
1	R305	Res,2E, 470	Ohmite	RC42GF471J
1	R309	Res,2W,1K	"	RC42GF102J
1	R310	Res,2W,180	"	RC42GF181J
1	R311	Res,¼W, 1K	"	RC07GF102J
1	R314	Res,¼W,680	"	RC07GF681J

PARTS LIST

Unit: Remote Control and Monitor
Part No:
Mfg: International Laser Systems, Inc.

Quantity	Code	Description	Mfg.	Mfg. Part No.
1	CR-1	Diode,Signal	GE	IN4154
1	M1	Meter, 0-1Ma		
1	R1	Res, ½W,150K	Ohmite	RC20GF154J
1	R2	Res, ½W, 33K	"	RC20GF333J
1	R3	Res, 1W, 8Ω	"	RC32GF080J
1	S1	Switch, SPST	Cont-West	G124
1	SP-1	Speaker, 8Ω, .1w		

APPENDIX V

SHOTS COUNTER

Description

The shot counter consists of a five digit electro-magnetic display counter driven from an electronic trigger pulse counter. The five digit counter registers every tenth flash of the laser. The counter facilitates data acquisition and maintenance log keeping with the laser system.

Functional Analysis (Figure IV-1)

The flashlamp trigger signal is applied to an integrated circuit divider . The output of the divider advances an electro-mechanical counter through a driver transistor. The trigger signal at pin N of the GP-300 board is amplified by Q305 and triggers a one-shot multivibrator composed of 2 gates of A301 and capacitor C306. The multivibrator insures noise immunity of the decade divider by preventing noise pulses due to theringing of the flashlamp firing voltage from advancing the counter during the period of the one-shot. The time period of the one-shot is not critical as long as it is longer than the ringing period of the high voltage trigger.

Dual F/F integrated circuits A302 and A303 are connected as a decade divider and produce a pulse at the output pin 8 of A303 for every 10 input pulses. This pulse is processed through a dual inversion by the remaining gates of A301 to obtain maximum noise immunity and applied to Q306, the counter driver. Q306 controls the current through the electro-magnetic counter.

APPENDIX IX

SYNCHRONIZED PULSE OUTPUT

Description

A pulse synchronized to the laser output (T_o pulse) is frequently necessary when the laser is operated as an integral part of a larger system such as a range-finding system. The synchronized pulse output of the laser transmitter fulfills this requirement by producing a positive, electrical pulse coincident with the laser light pulse. The pulse is produced directly by a light sensitive photodiode that samples a portion of the raw laser beam before it reaches the collimating telescope. This pulse is brought to a BNC connector on the transmitter panel.